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Superfund Record of Decision (EPA Region 7)
Cherokee County/Galena, Kansas (Second Remedial Action)
September 1989

(U.S.) Environmental Protection Agency, Washington, DC

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Superfund Record of Decision:

Cherokee County, KS

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16. Abstract (Limit: 200 words)

The Cherokee County site is a lead and zinc mining area in the southeastern corner of Kansas. The 25 square-mile Galena subsite is one of six subsites within the Cherokee County site and consists of large areas covered by mine wastes, water-filled subsidence craters, and open mine shafts. Many of the shafts are direct conduits to the shallow ground water aquifer which is the sole source of drinking water for approximately 1,050 persons residing outside of the Galena city limits. The approximately 3,500 Galena residents receive their water supply from two deep aquifer wells. EPA began investigations of the Galena subsite in 1985 and determined that the shallow ground water aquifer and surface water were contaminated with elevated concentrations of metals. EPA Region VII responded by installing water treatment units on several private wells. The first operable unit for this site was signed in 1987 and provided for the pumping of water from existing deep aquifer wells and subsequent distribution of the water to affected local residents through a pipeline network. This Record of Decision represents the second of two operable units and addresses the threat of contamination to the shallow ground water aquifer and surface water. The primary contaminants of concern affecting the ground water and surface water are metals including cadmium, lead, and zinc.

17. Document Analysis a. Descriptors

Record of Decision - Cherokee County, KS
Second Remedial Action
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Key Contaminants: metals (cadmium, chromium, lead, zinc)

b. Identifiers/Open-Ended Terms

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Cherokee County, KS

16. Abstract (Continued)

The selected remedial action for this site includes the removal, consolidation, and onsite placement in mine pits, shafts, and subsidences of surface mine wastes; diversion and channelization of surface streams with recontouring and vegetation of land surface; and investigation of deep aquifer well quality followed by plugging all abandoned and inactive wells and rehabilitating active wells, if necessary. The estimated present worth cost for this remedial action is $8,295,215, which includes an annual O&M cost of $14,963.

CHEROKEE COUNTY

GALENA SUBSITE

RECORD OF DECISION

GROUND WATER/SURFACE WATER

OPERABLE UNIT

SEPTEMBER 18, 1989

TABLE OF CONTENTS

PAGE

DECLARATION 1

1.0 Introduction 3

2.0 Site Location and Description. 4

3.0 Site History 5

4.0 Enforcement Activities 7

5.0 Community Relations History. 7

6.0 Scope and Role of Operable Unit. 8

7.0 Site Characteristics and Site Risks. 9

8.0 Post 1988 OUFS Studies 10

9.0 Development of Alternatives. 12

10.0 Description of Alternatives. 15

11.0 Development and Detailed Evaluation of the Selected Remedy 19

12.0 Summary of the Comparable Analysis of Alternatives 33

13.0 Selected Remedy. 36

14.0 Statutory Determinations 40

LIST OF FIGURES/TABLES

PAGE

Figure 1 - Cherokee County - Site Location. 4a

Figure 2 - Galena Subsite 4b

Figure 3 - Selected Remedy - Mine Waste Backfill 20a

Table 1 - Concentrations of Total Metals in Private Wells. 9a

Table 2 - Maximum Metal Concentrations in Surface Soil/Mine Waste. 9b

Table 3 - Comparison of Maximum Daily Intakes to RFDs and AICs for Soil Ingestion 10a

Table 4 - Comparison of Maximum Daily Intake to RFDs and AICs for Mine Waste Ingestion 10b

Table 5 - Galena Subsite Remediation Goals. 12a

Table 6 - Twelve Preliminary Alternatives - 1988 OUFS 14a

Table 7 - Selected Remedy - Detailed Cost Summary 25a

Table 8 - Contaminant - Specific ARARs. 26a

Table 9 - Location - Specific ARARs 26b

Table 10 - Action - Specific ARARs 26c

Table 11 - Evaluation of Alternatives. 34a

RECORD OF DECISION DECLARATION

OPERABLE UNIT REMEDIAL ALTERNATIVE SELECTION

SITE NAME AND LOCATION

Cherokee County Site - Galena Subsite
Cherokee County, Kansas

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the ground water/surface water operable unit for the Cherokee County site - Galena subsite in Cherokee County, Kansas, developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for this site. The attached index identifies the items which comprise the administrative record upon which the selection of the remedial action is based.

The State of Kansas has concurred on the selected remedy. A letter from the State of Kansas stating their concurrence is included in this Record of Decision package.

DESCRIPTION OF THE SELECTED REMEDY

The Galena subsite is one of six subsites in the Cherokee County site. The Galena subsite is divided into two operable units, alternative water supply and ground water/surface water remediation. The alternative water supply operable unit decision document was completed in December 1987. This Record of Decision addresses the ground water/surface water operable unit. The function of this operable unit is to reduce the risks associated with exposure to the contaminants at the Galena subsite. The improvements to the ground water and surface water quality at this subsite will be consistent with overall remediation of the Cherokee County site. The selected remedial action for this operable unit will also reduce the human exposure to the contaminants in the surface mine wastes; will reduce the metals contamination in the ground water and surface water; and will be protective of the Roubidoux aquifer.

The selected remedy consists of the following four major components:

- Removal and selective placement of the surface mine wastes

- Diversion and channelization of surface streams
- Recontouring and vegetation of land surface
- Investigation of deep aquifer wells

DECLARATION

The selected remedy is consistent with CERCLA as amended and with the NCP to the extent practicable. The selected remedy is protective of human health and the environment and is cost-effective.

The selected remedy satisfies the statutory preference for remedies that reduce toxicity, mobility or volume of hazardous substances, pollutants and contaminants as a principal element and that utilize permanent solutions to the maximum extent practicable in accordance with Section 121(b) of CERCLA, 42 U.S.C. Section 9621(b), which sets forth general rules for cleanup standards. The remedy does not employ alternative treatment or resource recovery technologies.

The selected remedy will achieve location-specific and action-specific Federal and State requirements that are legally applicable or relevant and appropriate for this remedial action; however, contaminant-specific requirements will not be met for hazardous substances, pollutants or contaminants that will remain onsite at completion of this remedial action. Compliance with such contaminant-specific requirements is technically impracticable from an engineering perspective in regard to the Galena subsite. According to Section 121(d)(4)(C) of CERCLA, 42 U.S.C. Section 9621(d)(4)(C), a remedy may be selected even though it does not attain legally applicable or relevant and appropriate requirements under limited circumstances, such as technical impracticability, provided that the remedy assures protection of human health and the environment. The selected remedy for the Galena subsite ground water and surface water cleanup is selected in accordance with this provision of CERCLA, 42 U.S.C., Section 9621(d)(4)(C).

Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with Section 121(c) of CERCLA, 42 U.S.C. §9621(c). As appropriate, additional reviews will be conducted each five years after the initial review.

9-18-89

Date

Morris Kay, Regional Administrator

1.0 INTRODUCTION

The purpose of this document is to describe the remedial action selected by the U.S. Environmental Protection Agency (EPA) for implementation at the Galena subsite of the Cherokee County site, Cherokee County, Kansas. This document also describes the decision-making procedures that were followed in selecting this remedial action.

The selected remedial action will remediate environmental problems affecting the public health and the environment at the Galena subsite. This action is one part of a response action for remediating a site containing hazardous substances. This action is referred to as an "operable unit" remedial action and will be consistent with the final remedy for the site. This operable unit remedial action is selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C Section 9601, et seq.

The decision-making processes regarding the Cherokee County site began with preliminary investigations, which led to the inclusion of the site on the National Priorities List (NPL), making the site eligible for use of Superfund monies for cleanup of the releases and threatened releases of hazardous substances at the site. Based on the large size of the site and general locations of mining activities, the site was separated into six subsites for further investigation and eventual cleanup.

Additional remedial investigations (RI) and two operable unit feasibility studies (OUFS) were conducted at the Galena subsite. The RI demonstrates that the shallow ground water within the Galena subsite contains levels of metals above primary maximum contaminant levels (MCLs) established by the Safe Drinking Water Act. Approximately 1,050 people who live in the Galena subsite use this contaminated shallow aquifer for their sole source of drinking water.

The first OUFS dealt with the provision of an alternative water supply. A Record of Decision to provide an alternate water supply was issued on December 21, 1987. The Cherokee County Rural Water District (RWD) No. 8 has been incorporated to facilitate construction, operation and maintenance of the water system. The water system consists of two deep aquifer wells, two elevated storage tanks and a water distribution system servicing approximately 450 residences.

The second OUFS pertains to the ground water/surface water remedial action. This study consists of two parts, the 1988 OUFS and 1989 OUFS Supplement, hereinafter referred to as the OUFS, unless referenced otherwise. The RI and OUFS conclude that there is a public health risk at the site due to ingestion of shallow ground water and mine wastes. A risk at the site to the environment also exists due to metals contamination in the surface water. In addition, the OUFS screened and evaluated remedial action alternatives that would affect ground water and surface water contamination and remediate surface mine wastes.

Surface mine wastes, left onsite as the result of the mining activities, are located throughout the subsite. Levels of lead and cadmium in the surface mine wastes exceed the acceptable intake levels through ingestion established by EPA reference doses (RfD) and acceptable intake for chronic exposure (AIC), as demonstrated in the OUFS. The mine wastes are readily accessible to human exposure as many mine waste piles are adjacent to homes and businesses in the subsite. Also, these areas of contamination are commonly used for recreational areas for off-road vehicles.

Surface waters in the subsite contain metals exceeding the ambient water quality criteria for the protection of aquatic life established by the Clean Water Act, as demonstrated in the RI and OUFS. Such levels of contamination inhibit the growth and development of aquatic life present within the waters of the subsite. The impact of the contamination is particularly evident in Short Creek which has little to no aquatic life.

The decision to implement the remedial action is based on the actual and threatened release of hazardous substances into the shallow ground water and surface water and the threat of direct human exposure to the contaminants in the surface mine waste piles and subsequent ingestion of the contaminants. These releases and threats are primarily the result of mining activities conducted at the subsite and weathering and oxidation of the mining wastes.

2.0 SITE LOCATION AND DESCRIPTION

The Cherokee County site is the Kansas portion of the Tri-State Mining District, which includes the lead and zinc mining areas in Jasper County, Missouri, Cherokee County, Kansas, and Ottawa County, Oklahoma. Cherokee County is located in the extreme southeastern corner of Kansas. As shown on Figure 1, the Galena subsite is one of six subsites identified within the Cherokee County site and encompasses approximately 25 square miles. A more detailed map of the Galena subsite including mine waste study zones is presented in Figure 2.

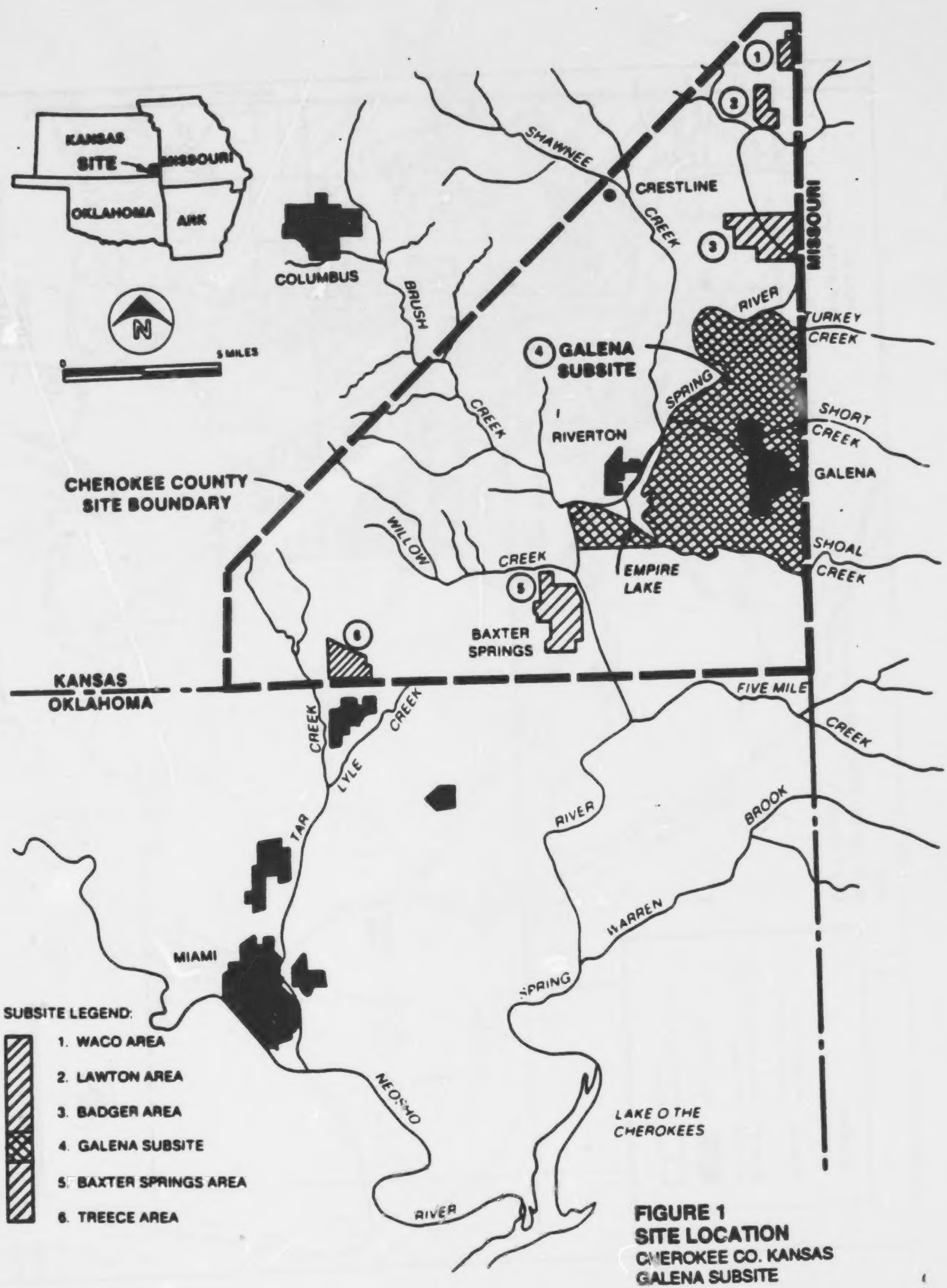

FIGURE 1
SITE LOCATION
CHEROKEE CO. KANSAS
GALENA SUBSITE

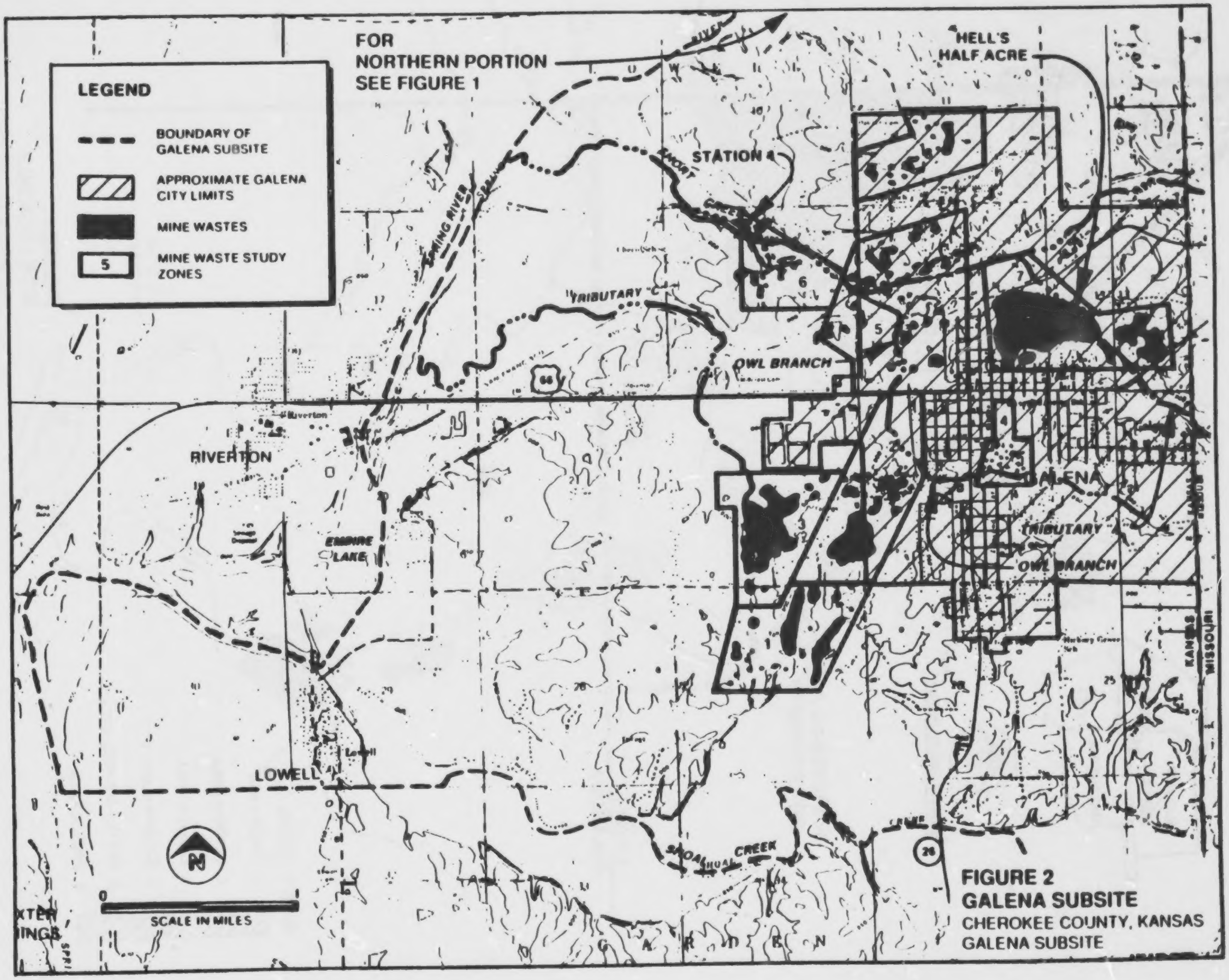

FIGURE 2
GALENA SUBSITE
CHEROKEE COUNTY, KANSAS
GALENA SUBSITE

The Galena subsite is characterized by surface mine waste features that directly impact the quality of the shallow ground water aquifer and the surface water. The mine waste areas contain sparse to no vegetation. Approximately 900 acres have been disturbed by the mining activities and are partially covered with surface mine wastes. The mined areas contain approximately 3,000 shafts including 580 open shafts and surface collapses, many of which are direct conduits to the shallow ground water. Short Creek and Owl Branch flow through the mined areas in the subsite. Shoal Creek receives runoff from the mined lands. Short Creek and Shoal Creek empty into the Spring River, which flows through the subsite and into Oklahoma.

The City of Galena, population approximately 3,500, is surrounded by the mine waste areas. Many houses are immediately adjacent to the mine waste piles. Approximately 1,050 additional people live within the subsite but outside of the city limits. The land in this rural area is primarily used for livestock grazing and crop production.

3.0 SITE HISTORY

Ore was first discovered in the Tri-State Mining District in 1848. The first economically significant mine in Kansas was in the City of Galena, where ore was discovered in 1876. Sphalerite (zinc sulfide) and galena (lead sulfide) were the important commercial ore minerals. The district was an important source of cadmium, which was produced as a by-product of the lead-zinc smelting process. Pyrite and marcasite (both iron disulfide) made up about five percent of the minerals in the Galena area. A smelter was built along Short Creek in the 1890's. The area near the original smelter was used for various smelting facilities until around 1961.

Ore deposits in the Galena vicinity occur from near surface to depths of 100 feet. This shallow depth allowed numerous small mining operations to prosper. Exploration and mine development were accomplished by excavating vertical shafts to locate the ore body. Mining progressed outward from the vertical shafts using a modified room and pillar method to follow the ore vein. The use of vertical shafts as a means of mineral exploration and the subdivision of leases into small mining plots resulted in a high density of mine shafts in the subsite. Several mines have collapsed, forming subsidences of varying sizes and shapes. Many circular subsidences are less than 75 feet in diameter while others, from circular to rectangular, measure several hundred feet along the longest dimension. A ground level difference of 20 to 40 feet is common in the subsidences within the subsite. Some subsidences are filled with water and may be deeper.

The most obvious remains of the intense mining activity at the subsite are large areas covered by mine wastes, water-filled subsidence craters and open mine shafts. The surface mine wastes include bullrock, dump material and chat. Bullrock and dump material consist of mostly coarse material and uneconomic ore removed from shafts and mine workings during excavation and mine development. The unprocessed bullrock and dump material remain near many of the open pits, shafts and subsidences. Bullrock and dump material will be referred to as waste rock hereinafter. Chat consists of fine-grained material that has been processed (milled) to remove the metal sulfide minerals. Little to no vegetation is found on the areas covered by the mine wastes.

The EPA began its investigation of the Galena subsite in 1985. A Phase I remedial investigation was completed in 1986. This investigation examined the effects of the mining activities on the ground water, surface water, ambient air, soils, stream sediments and fish. As the result of this work, EPA determined additional information on the ground water and surface water was necessary in order to evaluate potential remedial actions. These additional remedial investigations were conducted in 1986 and 1987. In 1988, EPA continued its investigation of the mine waste materials and developed a proposal for remediating the Galena subsite.

The subsite investigations demonstrated that the shallow ground water aquifer and the surface water in the subsite are contaminated with elevated concentrations of metals. Many private shallow aquifer wells are contaminated with metals that exceed the primary and secondary MCLs established by the Safe Drinking Water Act. Due to the concern for the health of persons drinking this contaminated water, EPA Region VII installed water treatment units on several wells as a temporary protective measure. These homes will be connected to the Cherokee County RWD No. 8 in the near future, within approximately two years.

In February 1988, the EPA released for public comment, a Proposed Plan to address the ground water and surface water contamination in the Galena subsite. As stated in the 1988 Proposed Plan, the preferred remedial alternative consisted of four components: 1) removing (mining), milling and processing (flotation) of the surface mine wastes; 2) channeling select streams and drainage areas; 3) recontouring the ground surface; and 4) investigating and remediating subsite deep wells. In response to comments received during the public comment period and to satisfy the need for additional information, investigations were subsequently conducted. These investigations determined that the milling and flotation component of the 1988 preferred remedy was not as implementable and economical as originally estimated. The remedy chosen in this ROD replaces the milling and processing component of the 1988 preferred remedial alternative with selective placement of surface mine waste below grade. This response activity will fill a majority of the pits, shafts and subsidences in the subsite.

4.0 ENFORCEMENT ACTIVITIES

General notice letters were issued to inform potentially responsible parties (PRPs) of their potential liabilities for past activities at the Cherokee County site. Nine PRPs were sent general notice letters in 1985. Two additional PRPs were notified of their potential responsibility in 1986. The original nine PRPs received notification prior to the installation of the individual water treatment units and prior to the remedial investigation. The PRPs indicated no desire to participate in either the remedial investigations or the operable unit feasibility studies.

A group of the PRPs have participated in investigatory activities conducted subsequent to the release of the 1988 Proposed Plan. These efforts have included various laboratory and field investigations. A laboratory study to better define the geochemical behavior of the surface mine waste and an onsite pilot study to assess the leaching potential of the mine wastes were conducted under EPA oversight and/or pursuant to EPA-approved work plans.

The EPA conducts periodic meetings with these PRPs to facilitate information sharing. Correspondence and summaries of technical discussions with the PRPs are provided in the administrative record. In May 1988, two additional PRPs were issued general notice letters as a result of new information on their involvement with the Cherokee County site.

5.0 COMMUNITY RELATIONS HISTORY

A public meeting was held in July 1985 prior to the remedial investigation to discuss the planned investigation and concerns relating to the previous mining activities. Another public meeting was held in May 1986 at the conclusion of the remedial investigation and prior to the removal action. At the conclusion of the OUFS for the alternative water supply, a public meeting was held in November 1987 and a public comment period was open for 39 days. All public meetings were held in Galena.

As required by Section 113(k)(2)(B) of CERCLA, 42 U.S.C. Section 9613(k)(2)(B), both the 1988 and 1989 proposed plans for the remedial action for the ground water/surface water operable unit were made available to the public. The information regarding their availability was announced in a newspaper notice and in a mailing to interested citizens. A public meeting was held in Galena in February 1988 to discuss the 1988 Proposed Plan. A public comment period on the OUFS and the 1988 Proposed

Plan was open for 54 days. A public meeting was held in Galena on August 3, 1989, to discuss the 1989 Proposed Plan and OUFS Supplement. A public comment period on the OUFS Supplement and 1989 Proposed Plan was open for 34 days. A responsiveness summary of public comments received during both the 1988 and 1989 public comment periods is part of this Record of Decision.

Information regarding EPA's activities at the site has been available at the Galena Public Library which has been used as an information repository and is the location for the administrative record. All community relations activities have been in conformance with the requirements of Sections 117 and 113(k) of CERCLA, 42 U.S.C. Sections 9617 and 9613(k), and to the extent practicable, the National Contingency Plan (NCP) 40 CFR Part 300 (1980).

A task force, formed to assist coordination of state and federal activities in Cherokee County, Kansas, continues to hold periodic meetings in Galena. This task force is comprised of representatives from the local community and state and federal agencies.

6.0 SCOPE AND ROLE OF OPERABLE UNIT

The ground water/surface water operable unit is the second of two operable units for the Galena subsite. The first operable unit addresses the alternative water supply for the residents who are dependent on the shallow aquifer for drinking water. These two operable units address the public health and environmental threats at the Galena subsite. Additional remedial investigation/feasibility study (RI/FS) and remedial design/remedial action (RD/RA) activities will be conducted at the other subsites as operable units.

7.0 SITE CHARACTERISTICS AND SITE RISKS

The site investigations and the OUFS for the ground water and surface water remediation demonstrate that the primary health risk at the Galena subsite is the ingestion of the shallow ground water and the ingestion of surface mine wastes. Environmental risks include the contamination of the surface waters with metals at levels exceeding Federal and State ambient water quality criteria and standards. These exceedances are of particular concern in Shoal Creek because the creek has been designated a habitat for one or more Kansas designated endangered species.

The RI and OUFS show that the surface mine waste piles, mine wastes remaining underground and unmined minerals in the bedrock are the sources of the contamination in the ground water and surface water. The availability of the sulfide minerals in the mine workings and dissolved oxygen in the ground water result in the production of sulfuric acid followed by dissolution of metal

TABLE 1
CONCENTRATIONS (ug/l)[a] OF TOTAL METALS OBSERVED IN PRIVATE WELLS

	Average	Maximum	Criteria
Barium	83.5	390	1,000[b]
Cadmium	5.6	180	10[b]
Chromium	6.8	120	50[b] (total)
Copper	14.5	140	1,000[cd]
Lead	25.5	230	50[be]
Manganese	92	3,400	50[c]
Mercury	0.14	0.44	2[b]
Nickel	23	270	150[f]
Selenium	3.8	24	10[b]
Silver	6.9	11	50[b]
Zinc	841	15,000	5,000[c]

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a = Micrograms per liter or parts per billion
b = Primary Maximum Contaminant Level (MCL), Safe Drinking Water Act
c = Secondary MCL, Safe Drinking Water Act
d = The proposed secondary MCL for copper is 1,300 ug/l
e = The proposed MCL for lead is 5 ug/l
f = Lifetime Health Advisory (EPA, Office of Drinking Water)

Table 2
MAXIMUM METAL CONCENTRATIONS IN SURFACE SOIL AND MINE WASTE
(mg/kg dry weight)[a]

Metal	Surface Soils Concentration[b]	Mine Waste Concentration[c]
Arsenic	20	27
Cadmium	12	79
Chromium (Total)	44	83
Copper	24U	110
Iron	22,000	53,000
Lead	510	3,880
Manganese	1,400	11,000
Nickel	16	NA
Selenium	3U	NA
Silver	6U	NA
Zinc	1,100	15,731

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a = Milligrams per kilogram (mg/kg) or parts per million (ppm)

b = Soil sampling in northern Galena

c = Metal concentrations determined by wet chemistry method

Notes: U = Element not detected; value represents concentration detection limit.

NA = Data not available or metal not measured.

sulfides. A similar action occurs on the surface with the minerals in the waste piles reacting with oxygenated rain and snow melt. The acidic metals-laden water is referred to as acid mine drainage. Acid mine drainage from the waste piles, runoff from the waste piles and contaminated ground water discharge to the streams, each contributing to the contamination of the surface water.

Approximately 510 households outside of the City of Galena depend on private wells in the shallow ground water aquifer for their drinking water. These wells are obtaining water from the same geologic formation that had previously been mined. The RI and OUFS show that the water from several of the private wells contains cadmium, chromium, lead, nickel and selenium exceeding the health-based drinking water standards. Table 1 lists the average and maximum levels of metals observed in private water wells during the RI for the subsite compared to the drinking water standards.

Exposure to the metals found in the private wells may cause harm to human health. Cadmium and chromium ingestion may cause kidney damage with chromium also potentially adversely affecting the liver. Ingestion of lead may cause nervous system and irreversible brain damage particularly in children. Nickel ingestion may affect body weight while ingestion of selenium can cause depression and gastrointestinal disturbances.

The RI and OUFS show that the mine wastes and soils contaminated with mine wastes also present a human health risk as a result of incidental ingestion of the material. As several of the waste areas are in close proximity to residential areas, exposures can occur in a residential setting by children and adults ingesting soil or vegetables incidentally through normal everyday activities, (i.e., playing or working in the yard, gardening and other similar activities). Exposures can also occur through breathing and inhalation of dust generated by such activities. The surface mine waste have been sources of gravel and fill material used on residential properties. Children and adults also are exposed to the metals in the mine wastes through recreational use of the mine waste areas. The mine waste areas are used for dirt bike and other off-road vehicle activities. Table 2 lists the maximum metal concentrations observed in surface soils and mine wastes.

Reference doses (RfDs) and acceptable intakes for chronic exposures (AICs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs and AICs are estimates of an exposure level that would not be expected to cause adverse effects when exposures occur for a significant portion of a lifespan. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water or soil) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., uncertainty factors among other things, account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur. Tables 3 and 4 show the comparison of maximum daily intakes to RfDs and AICs for soil and mine waste ingestion. Lead and cadmium are the metals of most concern due to incidental ingestion. Ingestion of the mine wastes represents the most significant exposure pathway for children, who more frequently than adults play in dusty areas and thus incidentally ingest that dust.

Analysis of samples taken from tributaries to Shoal Creek have shown concentrations of lead, zinc and cadmium exceeding both acute and chronic exposure criteria for aquatic life. Shoal Creek is of special concern with respect to potential environmental effects because natural caves near Shoal Creek provide a critical habitat for one or more species of salamanders listed as endangered by the State of Kansas.

Both the acute and chronic exposure levels for aquatic life for cadmium and zinc are exceeded in Short Creek and its tributarires. The chronic exposure level for lead is also exceeded in Short Creek.

The Spring River is impacted by mining activities in both Missouri and Kansas. Within the Galena subsite, both Short Creek and Shoal Creek discharge into the Spring River. The chronic exposure level for aquatic life for zinc is exceeded in the Spring River within the Galena subsite.

The public health related standards and environmental standards as compared to the number of exceedances for sample stations on Short Creek, Shoal Creek and Spring River are presented and discussed in detail in the RI report and 1988 OUFS.

8.0 POST 1988 OUFS STUDIES

In February 1988 EPA released a first Proposed Plan, describing the preferred remedy for the Ground Water/Surface Water Operable Unit. This Proposed Plan discussed five of the alternatives evaluated in the 1988 OUFS. The 1988 preferred remedy called for removal, milling and processing of surface mine wastes, recontouring the ground surface, rechanneling selected streams and drainage areas and investigating and remediating as necessary, deep aquifer wells. Comments received during the public comment period and the need for additional design information promoted efforts to further study remedial

Table 3
COMPARISON OF MAXIMUM DAILY INTAKES TO RfDs AND AICs FOR SOIL INGESTION

Metal	RfD or AIC (mg/kg/day)	Maximum DI (mg/kg/day) 10-kg Child	Maximum DI (mg/kg/day) 70-kg Adult	DI/(RfD or AIC)[b] 10-kg Child	DI/(RfD or AIC)[b] 70-kg Adult
Cadmium	0.0005(RfD)	0.00024	1.71E-5	0.48	0.034
Chromium (Total)[a]	0.0048(RfD)	0.00088	6.29E-5	0.18	0.013
Copper	0.037(RfD)	0.00048	3.43E-5	0.013	0.00092
Lead	0.0014(AIC)	0.0102	7.29E-4	7.29	0.52
Manganese	0.22 (AIC)	0.028	2.0E-3	0.13	0.0091
Nickel	0.010(RfD)	0.00032	2.29E-5	0.032	0.0023
Selenium	0.0030(AIC)	0.00068	4.86E-5	0.23	0.0016
Silver	0.0030(RfD)	0.00128	9.14E-5	0.43	0.0030
Zinc	0.21(AIC)	0.022	1.57E-3	0.10	0.0075
Hazard Index				8.88	0.6

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[a] = Comparison assumes all chromium is hexavalent (VI).

[b] = DI/(RfD or AIC) greater than 1.00 indicates a health risk.

Note: Assumes daily ingestion in a residential exposure scenario with a child ingestion rate (IR) of 0.2 gms/day and adult IR of 0.1 gms/day.
1 kilogram equals 2.2 pounds.

Table 4
COMPARISON OF MAXIMUM DAILY INTAKES TO RfDs AND AICs FOR MINE WASTE INGESTION

Metal	RfD or AIC (mg/kg/day)	Maximum DI (mg/kg/day)		DI/(RfD or AIC)[b]	
		10-kg Child	70-kg Adult	10-kg Child	70-kg Adult
Cadmium	0.0005(RfD)	0.0016	0.000113	3.16	0.226
Chromium (Total)[a]	0.0048(RfD)	0.0017	0.00012	0.346	0.025
Copper	0.037(RfD)	0.0022	0.000157	0.059	0.004
Lead	0.0014(AIC)	.0776	0.0055	55.5	3.96
Manganese	0.22(AIC)	.22	.0157	1	.071
Zinc	0.21(AIC)	.315	.022	1.5	0.107
Hazard Index				61.49	4.16

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[a] = Comparison assumes all chromium is hexavalent (VI).

[b] = DI/(RfD or AIC) greater than 1.00 indicates a health risk

Note: Assumes daily ingestion in a residential exposure scenario with a child ingestion rate (IR) of 0.2 gms/day and adult IR of 0.1 gms/day.

alternatives.

8.1 EPA Studies

In May 1988, the EPA initiated studies to determine process treatment parameters to mill and process the mine wastes. A more detailed understanding of specific process variables was also needed to respond to significant comments received during the public comment period on the 1988 preferred remedy. The primary objectives of the additional work were to collect samples of high- and low-grade mine wastes and then conduct metallurgical tests on these materials to better define design and operating parameters for the treatment process proposed.

Results of onsite characterization activities indicated that waste rock piles have a wide size distribution of materials with corresponding highly variable metals concentrations. A portable X-ray fluorescence (XRF) spectrometer used to semi-quantitatively identify lead and zinc concentrations of mine waste samples, indicated that many chat piles contained substantial lead and zinc concentrations. Wet screening and further chemical analyses on the chat samples showed that most of the lead was in the very fine-sized fraction of the chat. This fine-sized fraction includes the materials most likely to be ingested.

The results of the metallurgical tests revealed that the milling/flotation process required for sufficient metal (primarily lead, zinc, and cadmium) recoveries from both the waste rock and the chat would be far more complex than originally envisioned. For example, the waste rock was harder than expected, so the crushing and grinding circuits would be larger and more expensive to build and operate. In addition, these tests determined that the quantities of metal oxide forms present in both waste rock and chat would have to be recovered as well as the sulfides to produce satisfactory metals removal and an acceptable tailing. As a result, further tests and studies on the mine wastes were conducted and the Agency developed the 1989 OUFS Supplement. This OUFS Supplement re-evaluates the 1988 preferred remedy and evaluates additional remedial alternatives in light of the new information gathered subsequent to publication of the 1988 preferred remedy.

8.2. PRP Studies

In addition to the studies and testing conducted by EPA, a group of potentially responsible parties (PRPs) conducted field investigations and leach tests. The PRP group conducted column leach tests on waste rock, chat and a simulated mill process tailing to better understand the geochemical behavior of these wastes. The PRPs estimated volumes of the various mine wastes within the subsites's eight EPA-defined waste zones. This work indicated that there are about 550,000 cubic yards (yd^3) of waste rock (including associated contaminated soils) and approximately 750,000 yd^3 of chat. In addition, estimates of below-grade surficial (open to the surface) void-space volumes (with and without a shallow-water table influence) were determined. This work estimated that there is surficial void space of about 1.9 million yd^3, including approximately 0.8 million yd^3 holding water and 1.1 million yd^3 without water. These estimates of surface mine wastes are much higher than the estimates presented in the 1988 OUFS. The EPA has determined that the PRPs' estimates are more accurate since they have been based on detailed field reconnaissance. Analyses of mine waste rock and chat samples indicated that metal concentrations vary widely in the materials tested confirming previous EPA test results.

The PRP Group conducted onsite pilot leach tests, utilizing local mine waste rock, chat and water. Various mine wastes and waters from the subsite were subjected to several 24-hour batch tests and three flow-through tests of extended duration (approximately 8 days). Results of these tests support the EPA's remedy selected herein.

9.0 DEVELOPMENT OF ALTERNATIVES

The remedial alternatives for the ground water/surface water operable unit were developed and evaluated in compliance with CERCLA and the NCP. Section 121(b) of CERCLA, 42 U.S.C. Section 9621(b), provides that a remedy shall be selected that is protective of human health and the environment, that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The OUFS for the ground water and surface water remediation evaluates alternatives with respect to the requirements of that section.

9.1 Remediation Goals

Remediation goals for the Galena subsite include both long-term and short-term goals. Table 5 identifies both the long-term and short-term goals for the Galena subsite. Implementation of the selected remedial action for this operable unit will address both the short-term and promote achievement of the long-term goals.

9.2 Remediation Action Levels

The potential hazards to public health were also further evaluated subsequent to completion of the 1988 OUFS. The principal contaminant of concern at the Cherokee County site is lead. The Center for Disease Control (CDC) and, subsequently, the Agency for Toxic Substance Disease Registry (ATSDR) have historically supported using an action level for lead in soil of 1,000 mg/Kg (ppm) or below. This action level has been based on

Table 5
GALENA SUBSITE REMEDIATION GOALS

LONG-TERM

1. Protect the Roubidoux Aquifer from contaminant inflows within the bounds of the subsite.

2. Protect human health of the population within the subsite from mining-related contaminants in the ground water and surface water systems and in the surface mine wastes and soils.

3. Meet Kansas Ground Water Contaminant Cleanup Target Concentrations[a] in ground water within the subsite.

4. Meet both Federal and State Ambient Water Quality Criteria (AWQC) in surface streams, within the subsite.

SHORT-TERM

1. Protect the Roubidoux Aquifer from deep well contaminant inflows within the subsite.

2. Protect human health of the population within the subsite from mining-related contaminants in the ground water and surface water systems and in the surface mine wastes and soils.

3. Provide suitable drinking water (meet primary MCLs at existing taps) for the population within the subsite[b].

4. Improve water quality or reduce the volume of surface water entering the shallow ground water system within the subsite.

5. Reduce metals loadings in Short Creek, Shoal Creek and Spring River to support site-wide goals.

6. Improve water quality of the shallow aquifer within the Galena subsite.

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[a] Kansas Ground Water Contaminant Cleanup Target Concentrations are water quality criteria that apply to all fresh and usable water aquifers (Kansas Notification/Action Levels, KNL or KAL), and to alluvial aquifers or specific aquifers which surface through springs or seeps (Alternate Kansas Notification/Action Levels, AKNL or AKAL), however these criteria are non-promulgated standards.

[b] A suitable drinking water supply for the subsite has been addressed by the Alternative Water Supply OUFS.

studies which revealed elevated blood lead levels in children living on sites that contained greater than 500 ppm lead. On a case-by-case basis, the EPA has adopted a lead action level at 1,000 ppm or below for sites in a residential setting. Mine wastes in the Galena subsite are located directly adjacent to a number of residences and the community of Galena. The Agency has thus considered the Galena subsite a residential setting and adopted 1,000 ppm as the action level for lead at the subsite. As a result of this determination, the selected remedy will place mine wastes containing lead above 1,000 ppm below ground and potentially use mine wastes containing less than 1,000 ppm lead for cover material.

Land use restrictions will be established and maintained on the deeds of the properties affected by the remedial action. The State of Kansas or local government will establish these restriction to prevent mining and excavation in the remediated areas and to assure the integrity of the remedial action. These controls, however, will not restrict activities related to gardening, livestock grazing or residential exposures.

To assure that the health concerns related to cadmium are addressed, the Agency has established a cadmium level of concern at 25 ppm. Materials containing cadmium above 25 ppm will not be used for cover and will rather be placed below ground. The cadmium level of concern has been established based on consideration that future land use may include gardening (incidental and some subsistence use), livestock grazing or residential uses. Cadmium in soil greater than 10 to 20 ppm at other Superfund sites has been considered unacceptable for use in gardens. In addition, toxic effects have been exhibited in cattle grazing on vegetation containing 5 to 10 ppm cadmium. Calculations relating to residential exposures have supported less conservative levels of concern for cadmium at between 50 and 100 ppm. However, since restrictions on all types of land use are not anticipated, the Agency has determined that an appropriate level of concern for cadmium is 25 ppm.

In addition to lead and cadmium, a level of concern has been established for zinc concentrations contained in the mine waste chat due to its potential adverse effects to area biota and based on zinc's tendency to leach from the mine waste and migrate in ground water and surface water. The concentration of zinc in chat will dictate what chat is placed potentially below the ground water table. Based on results of the pilot leach tests, which were conducted using a mixture of chat and waste rock and local water having a pH greater than 5, chat containing the following levels of zinc will be placed as described below. Chat containing zinc above 10,000 mg/kg (ppm) will be placed in dry mine voids. Chat containing zinc below 10,000 ppm may be placed in either dry voids or voids containing water. The level of zinc contained in the chat is not the determining factor for what material is used as cover.

The majority of the existing chat piles have been characterized as to their metals content. These characterization efforts indicate that the distinction between piles of chat containing the above-described levels of zinc is easily determined and already appears to fall into the described categories. Minor volumes of chat, approximately 10 percent of the total chat volume, are estimated to contain greater than 10,000 ppm zinc. It is estimated that potentially greater than 60 percent of the chat contain concentrations of zinc at 5,000 ppm or below.

9.3 Initial Screening of Alternatives

The 1988 OUFS provides an initial screening of alternatives which included three major steps: 1) Prescreening of general response actions and technologies, 2) Screening of general response actions and technologies, and 3) Development and initial screening of potential remedial alternatives.

Twelve potential remedial alternatives were developed in the OUFS by assembling both the source control and management of migration general response actions remaining after the response action and technology screening. The alternatives listed in Table 6 were developed as required by 40 CFR Section 300.68(f) to the extent possible and appropriate. These alternatives conform to the requirements prescribed by Section 121 of CERCLA, 42 U.S.C. Section 9621 for remedial alternatives. As required by 40 CFR Section 300.68(g), each of the twelve potential alternatives were evaluated based on three broad criteria: cost, implementability and effectiveness.

The initial screening of potential remedial alternatives provided the basis for selecting five alternatives for detailed analysis in the 1988 OUFS. The general components of these five alternatives are provided in Section 10.1 of this Record of Decision. Following a detailed evaluation, EPA developed a modification to one of the five alternatives and presented it in the 1988 Proposed Plan as the preferred remedy, which is described in Section 10.2, herein.

Additional investigations and information gathering as described in Section 8.0 herein conducted after the publication of 1988 Proposed Plan highlighted the need for further alternative development and evaluation. Pertinent available data passing the OUFS screening and evaluation stages were retained for consideration in the development and further refinement of remedial alternatives. Five alternatives were thus developed and evaluated in the OUFS Supplement, based on information provided in the 1988 OUFS and the information gained from the studies and tests conducted subsequent to the publication of the 1988

Table 6

Twelve Preliminary Alternatives

1988 Operable Unit Feasibility Study

Alternative Number	Description
1	Mine and Treat Sulfide Minerals
2	Remove and Treat Surface Wastes, Backfill Shafts and Voids
3	Remove and Treat Surface Wastes, Partially Backfill Shafts and Voids
4	Remove and Contain Surface Wastes, Backfill Shafts and Voids
5	Remove and Contain Surface Wastes
6	Remove and Contain Surface Wastes, Treat Ground Water and Surface Water
7	Isolate Surface Wastes, Backfill Shafts and Voids
8	Isolate Surface Wastes, Treat Surface Water
9	Treat Surface Water
10	Treat Ground Water and Surface Water
11	Divert Surface Waters
12	No Action

Proposed Plan. Many of the alternatives evaluated in the OUFS Supplement incorporated the viable alternative components previously considered in the 1988 OUFS. The No-Action Alternative and the 1988 preferred remedy were considered in this evaluation. Section 10.3 herein describes each of the alternatives considered in the OUFS Supplement.

10.0 DESCRIPTION OF ALTERNATIVES

10.1 1988 OUFS

The 1988 OUFS developed 12 alternatives, five of which were evaluated in detail. A brief description of these five alternatives is provided below. The number assigned to each alternative discussed is the same number as in the 1988 OUFS. Additional details regarding these five alternatives may be found in the OUFS.

Alternative 2 - 1988 OUFS

The objective of this alternative is to remove the surface sources of metals contamination and metals loadings which affect acid mine drainage and to reduce the subsurface formation and migration of acid mine drainage. This alternative consists of four components:

1) Remove and treat surface mine wastes via milling and flotation to remove the surface source of the contaminants and acid mine drainage;

2) Backfill existing mining shafts and voids to reduce direct inflow of surface water, reduce dissolved oxygen availability to the subsurface void spaces and reduce the permeability in the subsurface material;

3) Recontour land surface to improve drainage and reduce surface water infiltration into the mineralized zone; and

4) Investigate deep aquifer wells and remediate as necessary to protect the Roubidoux aquifer.

Alternative 3 - 1988 OUFS

The objectives of Alternative 3 are the same as Alternative 2; however, Alternative 3 requires a longer time period to meet the long-term goals. Alternative 3 consists of the following actions:

1) Remove and treat surface wastes via milling and flotation to remove the surface sources of the metal contaminants and acid mine drainage;

2) Divert and channelize some portions of streams to reduce surface water infiltration into the mineralized zone;

3) Recontour land surface to improve drainage and reduce surface water infiltration into the mineralized zone;

4) Limited backfilling with the tailings from the treatment to form ground water cutoffs to reduce the permeability and reduce oxygen availability to subsurface minerals in a few selected areas; and

5) Investigate deep aquifer wells and remediate as necessary to protect the Roubidoux aquifer.

Alternative 5 - 1988 OUFS

The objective of Alternative 5 is to isolate the surface sources of metals contamination and acid mine drainage.

Alternative 5 consists of the following components:

1) Remove surface mine wastes;

2) Consolidate the surface mine wastes into a containment unit to contain the surface source of metals contaminants;

3) Divert and channelize portions of streams to reduce surface water infiltration into the mineralized zone;

4) Recontour the disturbed areas to reduce surface water infiltration into the mineralized zone; and

5) Investigate deep aquifer wells and remediate as necessary to protect the Roubidoux aquifer.

Alternative 10 - 1988 OUFS

The objective of Alternative 10 is to reduce the levels of metals in the ground water and surface water without source controls. Alternative 10 consists of the following components:

1) Treat surface water via wetlands to reduce metals present in the surface water;

2) Pump and treat ground water to reduce metals present in the ground water and surface water;

3) Divert and channelize portions of the streams to reduce surface water infiltration into the mineralized zone;

4) Recontour the disturbed areas to reduce surface water infiltration into the mineralized zone; and

5) Investigate deep aquifer wells and remediate as necessary to protect the Roubidoux aquifer.

Alternative 12 - 1988 OUFS

Alternative 12 is the no-action alternative. The National Contingency Plan, 40 CFR Section 300.68(f)(1) requires that the no-action alternative be included in the evaluation. No action means that no further action will be taken at the site.

10.2 1988 Preferred Remedial Alternative

The 1988 preferred alternative was developed subsequent to a thorough review of the five alternatives previously described and evaluated in the OUFS. The objective of the 1988 preferred alternative is to remove the surface sources of metals contamination and metals associated with acid mine drainage, which will improve the quality of the ground water and surface water and reduce the threat of incidental ingestion of the metal contaminants in the surface mine wastes. The 1988 preferred alternative consists of four components:

1) Remove and treat surface mine wastes via milling and flotation to remove the surface source of the contaminants;

2) Recontour and revegetate the land surface to control erosion and to reduce surface water infiltration to the mineralized zone;

3) Channelize and divert stream channels to reduce metals loadings in the streams and to reduce surface water infiltration into the mineralized zone; and

4) Investigate deep aquifer wells and remediate as necessary to protect the Roubidoux aquifer.

10.3 1989 OUFS Supplement

As previously stated, additional information gathered in response to comments received on the 1988 Proposed Plan and OUFS prompted further evaluation of the alternatives for remediating the subsite. The first component of the 1988 preferred remedy was reevaluated with the information gained during the post-OUFS studies. This information caused the implementability of the preferred remedy to be questioned. In addition, other information gained during this period supported development of additional alternatives.

Five alternatives were developed and evaluated in the OUFS Supplement. The no-action alternative was considered in the evaluation. The four action alternatives consisted of a primary component to remediate the surface mine wastes: two treatment alternatives; a containment alternative; and selective placement below grade alternative. These primary components of each alternative are described below. In addition, the four action alternatives shared three common components:recontour/ vegetation; channelization of certain streams; and investigation/remediation of deep wells. These three common components are described above in Section 10.2. Additional details of these five alternatives may be found in the OUFS Supplement. The number assigned to each alternative discussed is the same as the number in the 1989 OUFS Supplement.

Alternative 1 - 1989 OUFS Supplement

Alternative 1 is the No Action Alternative.

Alternative 2 - 1989 OUFS Supplement

Alternative 2 meets the same objectives and consists of components similar to the 1988 preferred alternative described above. However, these components have been reevaluated in the OUFS Supplement based on the new data. The first component has been changed to the following:

Remove and treat all mine waste rock and chat. These mine wastes would be hauled to centrally located stockpiles adjacent to the processing facility. The waste rock and select portions of the chat would be milled and passed through flotation circuits to remove metals. Processed tailing material would be disposed of in adjacent mine workings.

Alternative 3 - 1989 OUFS Supplement

This alternative has the same objective as Alternative 2, however, it selectively deals with the mine wastes under the first component which provides for the following:

Remove and treat all mine waste rock and approximately one-half of the chat. One-half of the chat is assumed to contain lead above the action level. Hauling and processing would be carried out as discussed in Alternative 2 - 1989 OUFS Supplement.

Alternative 4 - 1989 OUFS Supplement

Alternative 4 provides for containment of all mine wastes to essentially eliminate the human exposure pathway from metal contaminants in the mine wastes and reduce ground water and surface water metals loading. The first component provides the following:

Remove and transport all mine waste rock and chat to a single containment unit. The unit would be designed to meet RCRA design criteria for hazardous waste.

Alternative 5 - 1989 OUFS Supplement

The objective of Alternative 5 is to remove the source materials from the surface and selectively place them in mine voids to essentially eliminate the risk posed by ingestion of metal contaminated waste. Alternative 5 would be implemented in a manner that promotes improvement of the shallow ground water and surface water quality. The first component provides the following:

Remove all mine waste rock and chat and selectively place the material in available pits, shafts and subsidences. Waste rock would be placed below ground based on size. Chat would be characterized as to lead and zinc content and placed below ground or used for surface cover based on metal content.

11.0 DEVELOPMENT AND DETAILED EVALUATION OF THE SELECTED REMEDY

11.1 Description

Alternative 5 - 1989 OUFS Supplement is the selected remedy. The four components of this alternative are described in detail as follows:

The selected remedy is to mine, characterize and selectively place surface-deposited mine wastes (waste rock and chat) in open subsidences, pits and shafts. This action will essentially eliminate human exposure via ingestion to contaminated mine wastes and reduce long-term shallow ground water and surface water metals loading. The selected remedy includes diverting and rechanneling certain surface drainages and recontouring and vegetating the ground surface to the extent possible. These actions will minimize recharge to the shallow ground water system, reduce infiltration through the cover material, promote proper surface drainage and control erosion. The selected remedy requires investigation and remediation, as necessary, of wells penetrating the deep aquifer to protect against contamination from the shallow aquifer and mining-related activities.

11.2 Mining, Screening and Placement of Waste Rock

Within a given zone, waste rock will be removed, transferred to a nearby portable screening plant and then dry screened at a nominal two-inch size. Tests indicate that the minus two-inch (finer) size fraction of waste rock will be highly reactive with acidic mine waters. The greater surface area to volume ratio of the finer-sized waste rock promotes this reactivity. In addition, dry screening at this size is very fast and efficient, and some moisture is easily tolerated. Effective screening at smaller sizes becomes more difficult. Field observations indicate that about 45 percent (250,000 yd^3) of the waste rock volume may be plus two-inch in size. The coarser material will be transported, backfilled and compacted in preinventoried mine voids. Preferably, all wastes should be placed above the water table. If the mine void to be filled is completely above the seasonal high water table, the mine wastes filling it will not require screening. Figure 3 presents a schematic of a backfilled mine void.

The fine-sized mine waste rock will also be placed in subsidences, but above the seasonal-high water table. Subsequently, chat characterized as having lead concentrations below the action level and cadmium below the established level of concern, will be used as a cover material to control erosion. Field engineering studies to balance cut and fill quantities of characterized chat and waste rock and to determine wet and dry subsurface void space will be required to minimize handling and haulage of the mine waste types. The waste rock screening plant should be relocated from area to area as necessary to avoid excessive waste rock haul distances for processing and placement.

11.3 Characterization and Placement of Chat

Chat will be characterized with the XRF spectrometer to determine metals concentrations. The XRF is a portable device that has a proven efficient capability to semi-quantitatively identify lead and zinc concentrations in prepared mine waste samples. The chat classified above the action level for lead and with lower zinc concentrations will be used as supplemental fill with the coarse waste rock material disposed of below grade. Partial mixing of the chat with the coarse waste rock fills the void space created by the removal of the finer-sized rock. This may reduce settling and reduce maintenance of the cover material. Additional engineering design is required to finalize the fill composition. Chat with high zinc concentrations will be disposed of below grade with the waste rock fines to mitigate migration of zinc to ground water.

Chat below the action level for lead and below the level of concern for cadmium will be used as a cover material. A compacted chat cover should reduce infiltration of precipitation into the backfilled mine voids.

11.4 Recontour/Vegetation

Following removal of the surface mine wastes, the disturbed areas will be recontoured to eliminate closed basins (ponded

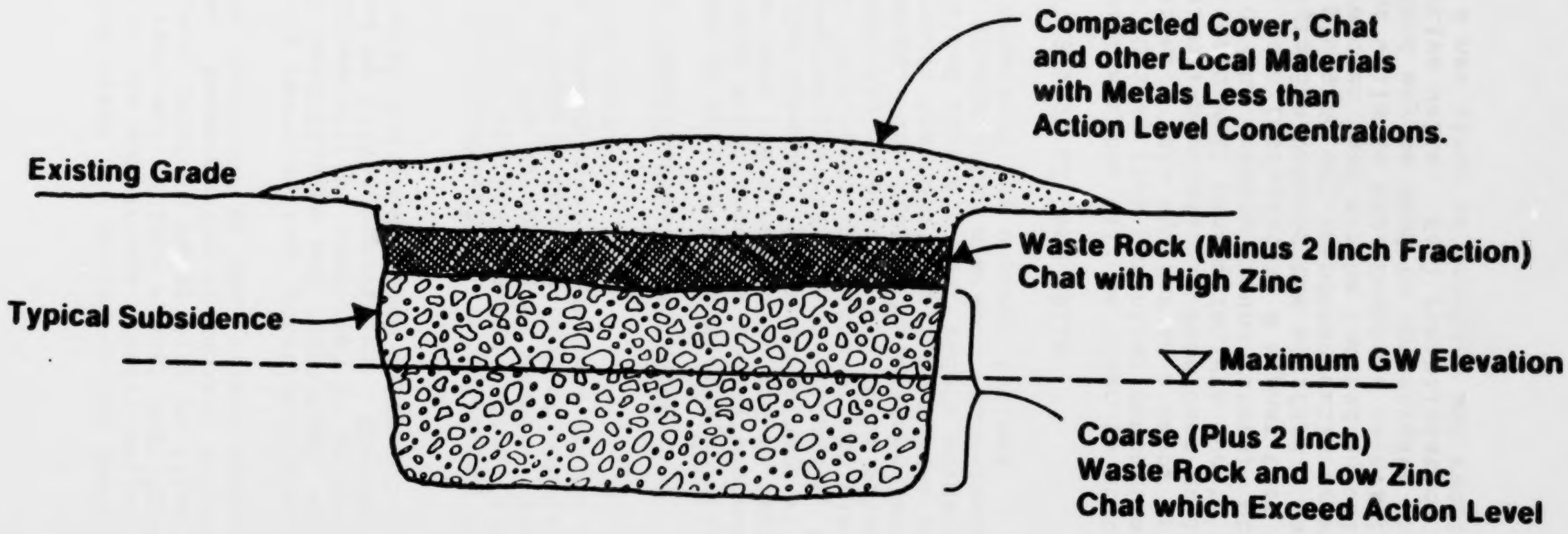

FIGURE 3
SELECTED REMEDY
MINE WASTE BACKFILL
CHEROKEE COUNTY, KANSAS
GALENA SUBSITE

areas) and low areas and to reduce the quantity of water that infiltrates to the subsurface. Recontouring will minimize ponding and redirect surface runoff away from mine shafts and permeable areas. Surface water will be directed into channelized drainageways. Recontouring to control drainage on the disturbed areas will be completed as the surface wastes are removed.

Following recontouring, additional erosion control measures, such as soil conditioning and vegetation, will be implemented. These activities will be conducted on an estimated 600 acres of land impacted by mining activities. The erosion control measures will be designed and constructed so as not to require long-term maintenance.

Selectively backfilling, recontouring and vegetating will essentially eliminate the exposure threat from ingestion of the contaminants in the surface mine wastes. The activities will also nearly eliminate the leaching of metals from the mine waste piles to the ground water and metals runoff from the waste piles to the surface streams.

11.5 Stream Channelization/Diversion

Portions of surface water drainages will be channelized and diverted around subsidences to reduce the surface water infiltration into the mined zones and to improve the water quality in the streams. Surface drainage will be diverted around specific areas to prevent stream capture by mine shafts and subsidences. The exact locations of the planned stream channelization and diversions are to be determined during remedial design. The planned diversions include concrete-lined channels through the Hell's Half Acre area and the Blue Hole area. The lined channels will reduce surface water recharge to the shallow ground water system. Acid-resistant concrete will be used to construct the channel linings.

11.6 Investigation of Deep Wells

Remedial actions will be taken to protect the deep (Roubidoux) aquifer from potential contaminant migration from the shallow aquifer. This aquifer is a major drinking water supply for the regional population. Some deep wells in the subsite may have experienced well casing failure due to the acidic corrosive conditions of the shallow ground waters. Other old wells may simply have been installed in a manner that creates a pathway for vertical migration between the aquifers. Remedial actions will consist of plugging all abandoned wells or wells not in active use and boreholes that can be located as well as determining the integrity of wells in use. Downhole television cameras or a similar method may be used to investigate the integrity of existing active wells. Well rehabilitation may include installing a new liner or grouting and redrilling the well. This remediation work if necessary will be conducted on wells identified as extending to and threatening the quality of the Roubidoux aquifer.

11.7 Operation and Maintenance

The operation and maintenance needs for this remedy consist mainly of maintenance of the lined channels. In addition, the compacted chat backfill used to cover the mine wastes disposed of in the mine subsidence areas, pits and shafts placed will require routine inspection for erosion and settling problems. Additional backfill may have to be placed to maintain design grades. Vegetative cover may require additional maintenance to assure a stabilized cover and to control erosion.

11.8 Other

Activities will be designed and implemented to mitigate adverse health affects on the wildlife and their habitats. Portions of the Shoal Creek and Spring River have been designated as critical habitats for threatened or endangered species and/or migrating birds and, therefore, must be protected during implementation. It was believed that an endangered species of bats inhabited portions of the subsite during the summer months. However, a recent investigation by the U.S. Fish and Wildlife has determined that the gray bat does not inhabit the area affected by the remedial action.

11.9 Implementability

The selected remedy has no major implementation issues. The technologies involved for each of the activities are available and easily applied to the Galena subsite. Surface mine waste removal and selective backfilling of waste rock and chat into the mine voids present some concerns due to the instability of the ground from subsurface mine voids within the disturbed areas. Vegetation will require proper selection of grasses and soil conditioning to establish a vegetative cover. The estimated time required to implement this remedy, including detailed design, is about three years. Additional time to establish adequate vegetative cover may be required.

It will be necessary to obtain access to the mined areas and areas containing surface mine wastes within the Galena subsite to proceed with implementation. Most of the land is privately held and individual access agreements may be obtained to conduct the activities.

All activities will be conducted onsite, therefore, according to Section 121(e) of CERCLA, 42 U.S.C. 6921(e), it will not be necessary to obtain state or federal permits. Coordination with other Federal Agencies, State agencies and EPA programs will ensure compliance with necessary environmental laws and regulations.

11.10 Reduction of Mobility, Toxicity or Volume

The selected remedy will not reduce the volume or toxicity of waste remaining onsite although the volume of wastes on the surface will be reduced. The threat to human health due to the ingestion of the mine wastes will be essentially eliminated by placement of mine wastes containing lead and cadmium above the action level below the ground surface and covered with chat material and vegetation. The mobility of the contaminants may continue over the short term, and over the long term the mass loading of contaminants to the ground water and area streams will be reduced.

In order for the deep well remedial actions to be fully effective, all deep wells and boreholes will have to be investigated and remediated as necessary to protect the Roubidoux aquifer. Remediation of wells that extend to the deep aquifer will prevent potential migration of metals from the mined zone to the deep aquifer through those pathways. Additional routes of migration are natural fractures in the rock which will not be plugged. Therefore, a potential for migration will still exist.

11.11 Short-Term Effectiveness

The pilot leach test indicates that potentially during and after remedy implementation, a short-term increase in leachable metals will be experienced in the shallow ground water and connected surface waters. This condition may occur during implementation of the selected remedy and for a few years after completion of the remedial action. However, over the long term, this remedy will result in an improvement to the area water quality.

An additional concern over the short term is the risk associated with waste removal and selective backfilling activities because of the instability of the mined areas. Field operations may cause ground subsidences, potentially resulting in injury to construction workers. Transportation of mine waste represents a minor risk to the environment. During mine waste excavation and removal activities dusts may be generated. An accident could possibly result in the release of metal contaminants to the environment. During implementation, suspended solids could increase in the streams, thereby creating a short-term risk to the aquatic life. Efforts will be taken to minimize such effects through use of dust suppressants, covered transport vehicles and other practices. Appropriate safety measures will be considered and incorporated during the remedial design phase.

During backfill of mine wastes into water-filled voids, displacement of the water could occur. Due to the length of time over which the backfilling will be implemented, displacement of water will be gradual and, therefore, have minimal impact to the quality of ground water and surface water. The time required to complete the mine waste removal and disposal remedial actions will be approximately two years.

11.12 Long-Term Effectiveness and Permanence

The selected remedy will essentially eliminate the threat of human exposure to the contaminants via ingestion by removing the surface waste piles. The environmental risks will be reduced by lowering the contaminant levels over the long term in the surface waters. The pilot leach test results suggest that over the long term the selected remedy will reduce the leaching and migration of metal contaminants. The mass loadings model in addition to the data from the pilot leach test supports this anticipated decrease in the metals loading over the long term.

The metals remaining at the ground surface after implementation of this remedy will continue to persist in the soils and mine waste remnants. The mobility of the subsurface metals will be slightly reduced because of the reduction in acid mine drainage generation. Selective placement of surface mine waste below grade, surface recontouring and surface water diversions and channelization will assist in reducing oxygen and water contact with sulfide minerals, therefore, reducing the formation of acid mine drainage.

Based on the model, it is predicted that individual overall contaminant loadings to the surface streams will be reduced by approximately 20 to 30 percent upon completion of the selected remedy. Contaminant-specific ARARs will not be achieved in the short term. Completion of this remedy will positively contribute to the long-term goal of meeting state and federal cleanup criteria.

After implementation, operation and maintenance activities will be required for lined channels and erosion control of subsidence of the backfilled areas. Monitoring will be required to evaluate long-term effectiveness because contaminants are not removed from the site by the remedial activity. Water quality monitoring during the first year after completion of the remedial action and at subsequent five-year intervals will be used to evaluate effectiveness of the remedy.

Long-term reliability of the technologies involved is expected to be high. Selective placement of the surface mine wastes below grade in mine voids is a permanent and irreversible process. If the lined channels, diversion channels, recontouring or vegetation fail, they may require replacement. However, land use restrictions will be used by the State of Kansas and/or the local government, as institutional controls to prevent damage to restructured channels and recontoured and vegetated surfaces.

11.13 Cost

A detailed summary of the costs associated with the selected remedy is shown in Table 7. The costs are order of magnitude (+50 percent to -30 percent) estimates. The assumptions and limitations of these estimates are presented in the OUFS Supplement report. These costs are those required to initiate and install the selected remedial action. Capital costs include construction equipment, labor and material expenditures, engineering and construction management. Bid and scope contingencies are also included in the total capital cost.

Present worth analysis is a method of evaluating expenditures that occur over different time periods. By discounting all alternative costs to a common year (Year 0), the costs for different alternatives can be compared on the basis of a single figure for each alternative. This single figure represents the amount of money in current dollars needed to cover all the expenditures associated with an alternative. Present worth values are calculated using a 5 percent discount rate. This analysis assumed a 30-year life cycle (for alternative comparison). Table 7 presents the present worth for the selected remedy. Capital costs, long-term operations and maintenance (O&M) costs, capital equipment replacement costs and five-year review costs are included in the total present worth value. Long-term O&M costs are those associated with maintaining the remedy after implementation is complete. Capital replacement costs are those associated with replacing certain portions of the remedy (i.e., lined channels, recontoured surfaces, stream diversions) after implementation.

To develop the cost estimates, it is necessary to make assumptions regarding labor and material costs, site conditions, etc. If actual conditions vary substantially from those used to develop these estimates, the cost of the remedy might be outside the order-of-magnitude range presented here. Factors such as deviations in estimated labor and material costs are not considered significant to the extent of altering total costs to values outside the order-of-magnitude range.

The primary factors that affect the capital and O&M costs include:

- Actual volume and tonnage of the surface mine wastes;

Table 7

SELECTED REMEDY
DETAILED COST SUMMARY

I.	Actions to Support Mine Waste Disposal		Costs
A.	Remove/Dispose Mine Wastes		$3,714,723
B.	Placement of Cover Material		1,012,302
C.	Support Site Work		236,351
D.	Mine Wastes Screening Plant		
	1. Capital Costs		192,000
	2. Operating Costs		185,529
E.	Supporting Field Work		
	1. Chat Characterization		393,400
	2. Cut/Fill Engineering		197,200
II.	Recontour/Vegetation 568 acres at $1000/acre		568,000
III.	Rechannelization		696,000
V.	Deep Well Investigation/Remediation		175,600
V.	Water Quality Monitoring		170,000
PROJECT COSTS		SUBTOTAL	7,541,105
Contingencies			754,110
			8,295,215

OPERATION AND MAINTENANCE - ANNUAL

Cover Maintenance		10,123
Channel Maintenance		3,480
	SUBTOTAL	13,603
Contingencies		1,360
		14,963

- Discount factor applied to O&M and capital replacement costs;
- Availability of suitable voids in relation to nearby mine waste types and volumes; and
- Location and availability of low lead/zinc chat or other cover material.

The discount rate affects the present worth of any future costs associated with the remedy. The smaller the discount rate, the larger the present worth for any given future expenditure.

Section 121(b) of CERCLA, 42 U.S.C. Section 6921(b), requires the consideration of "the potential for future remedial action costs if the alternative remedial action in question were to fail." Failure of the selected remedy will require replacement of surface water diversions or channels, recontouring or vegetating operations. The maximum potential cost is 100 percent of the initial cost for those remedial activities.

11.14 Compliance with ARARs

The results of the mass load modeling show that the average water quality in the surface water on Short Creek downstream of Galena will not meet the contaminant-specific applicable or relevant and appropriate requirements (ARARs) for cadmium and zinc following implementation of the selected remedy.

The selected remedy will provide some improvement in the long term in the quality of selected shallow ground water wells where the wells are intersecting fractures in direct contact with the mine workings. However, it is assumed for this evaluation that shallow ground water quality will not improve significantly in the Galena subsite as a result of this remedy. Therefore, in the short term, contaminant-specific ARARs as shown on Table 8 for the subsite will not be achieved as a direct result of this remedial action. The selected remedy will achieve the location- and action-specific ARARs shown in Tables 9 and 10.

Contaminant-Specific ARARs

The contaminant-specific ARARs may not be achieved by this remedial action. The contaminant-specific ARARs are identified in Table 8 and discussed herein in order to establish appropriate cleanup levels, even though such levels may not be achieved by this remedial action. Numerous heavy metals have been detected in the ground and surface waters at the subsite. The elements of most concern are lead, cadmium and zinc. Other metals are presented in Table 1 for informational purposes because they were detected in the ground and surface waters.

Table 8
CONTAMINANT-SPECIFIC ARARs
CHEROKEE COUNTY SITE
GALENA SUBSITE

Contaminant	CWA	Federal (SDWA) (ug/l)			Kansas (ug/l)	
	Human Health	MCL			Domestic Water Supply	Kansas Action Level[a]
		Primary	Secondary	MGLG		
Arsenic	--	50	--	50	50	50
Barium	-	1,000	--	1,500	1,000	1,000
Cadmium	10	10	--	5	10	5
Chromium (VI)	50	50 (total)	00	120 (total)	50	50
Copper	1,000	--	1,00	1,300	-	1,000
Iron	--	--	300	--	--	300
Lead	50	50	00	20	50	50
Manganese	--	--	50	--	--	50
Mercury	10	2	--	3	2	2
Nickel	15.4	--	--	--	--	1,000
Selenium	10	10	--	50	10	45
Silver	50	50	--	--	50	50
Zinc	5,000	--	5,000	--	--	5,000

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[a] KAL--Groundwater Contaminant Cleanup Target Concentrations for fresh, usable aquifer.

AQUATIC LIFE

Contaminant	Federal (CWA) (ug/l)		Kansas (ug/l)			
	Aquatic Life		GW Targets[a]			
	Chronic	Acute	AKNL[b] (Chronic)	AKNL[b] (Acute)	Aquatic Life Chronic	Aquatic Life Acute
Arsenic	190	360	--	--	190	360
Barium	--	--	--	--	--	--
Cadmium	1.1	3.9	--	--	0.66[e]	1.8[c]
Chromium (VI)	11	16	--	--	11	16
Copper	12	18	26	42	6.5[c]	9.2[c]
Iron	1,000	--	--	--	1,000	--
Lead	3.2[e]	82[e]	--	--	1.3[c]	34[c]
Manganese	--	--	--	--	--	--
Mercury	0.012	2.4	0.012	2.4	0.012	2.4
Nickel	160	1,400	--	--	88[c]	789[c]
Selenium	35	260	5	20	35	260
Silver	0.12	4.1	0.12	198[d]	0.12	1.2[c]
Zinc	110	130	231	255	59[c]	65[c]

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[a] Groundwater Contaminant Cleanup Target Concentration (aquifer discharge via springs or seeps to surface). Nonpromulgated. These levels are to be considered in performing this action.

[b] Alternative Kansas Notification/Action Levels applies to aquifers that surface through springs or seeps.

[c] Hardness dependent (value based on $CaCO_3$ less than 150 mg/l).

[d] Hardness dependent (value based on 251-400 mg/l $CaCO_3$).

[e] Hardness dependent (value based on 100 mg/l $CaCO_3$).

Table 9
FEDERAL AND STATE LOCATION-SPECIFIC ARARs

Location	Requirements	Citation
Within flood plain	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values	Executive Order 11988, Protection of Flood Plains 40 CFR 6, Appendix A
Within areas where action may cause irreparable harm, loss, or destruction of significant artifacts	Action to recover and preserve artifacts	National Archeological and Historical Preservation Act (16 U.S.C. Section 469); 36 CFR Part 65
Historic project owned or controlled by federal agency	Action to preserve historic properties; planning of action to minimize harm to National Historic Landmarks	National Historic Preservation Act, Section 106 (16 U.S.C. 470 et seq.); 36 CFR Part 800
Critical habitat upon which endangered species or threatened species depend	Action to conserve endangered species or threatened species, including consultation with the Department of Interior	Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.); 50 CFR Parts 17 and 402; 40 CFR 6.302, K.A.R. 23-17-1
	Action to conserve threatened or endangered species, in consultation with Kansas Fish & Game Commission	Kansas Nongame and Endangered Species Conservation Act of 1975, KSA 32-501
Wetland	Action to minimize the destruction, loss, or degradation of wetlands	Executive Order 11990, Protection of Wetlands (40 CFR, 6, Appendix A)
Area affecting stream or river	Action to protect fish or wildlife	Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.); 40 CFR 6.302

Table 10
ACTION-SPECIFIC ARARs--FEDERAL AND STATE

Remedial Measures	ARARs	Comments
Removal of Sulfide Minerals	30 U.S.C. 801--Federal Mine Safety and Health Act	Pertains to worker safety at mining operations
	40 CFR 122, 125--National Pollutant Discharge Elimination System and 40 CFR 440--Effluent Limitations	Regulates the discharge of pollutants from any point source into waters of the United States or Kansas and sets technology-based effluent limitations for point source discharge in the Ore Mining and Dressing Point Source Category
Shaft and Mine Backfilling	30 U.S.C. 801-962--Federal Mine Safety and Health Act	Pertains to worker stafety at mining operations
	Surface Mining Control and Reclamation Act 30 U.S.C. §§ 1201 et. seq. and 30 CFR Part 816, particularly §§ 816.56, 816.97, 816.106, 816.111 to 816.116, 816.133, and 816.150	Regulates backfilling and recontouring previously mined areas, and other rehabilitation of past mining areas. This standard is to be considered in performing this remedial action
	Clean Water Act, Section 404; 40 CFR, Parts 230 and 231	Action to prohibit discharge of dredged or fill material into wetland without permit
Investigation/Remediation of deep wells, as necessary	Kansas Administrative Regulation 28-30-1	Regulate construction, reconstruction, treatment, and plugging of water wells
Surface Water Channeling	40 CFR 230-231, Section 404 of the Clean Water Act--Dredge or Fill Requirements	Establishes requirements for discharge of dredged or fill materials, or work in or affecting, navigable waters
	Clean Water Act, Section 404, 40 CFR 125, Subpart M, and 33 CFR 320-330 -- Rivers and Harbors Act -- Section 10 Permit	Action to dispose of dredge and fill material into waters is prohibited without a permit

Table 10
(continued)

Remedial Measures	ARARs	Comments
General	29 U.S.C. 651 et seq. Occupational Safety and Health Act	Regulates worker health and safety. Applies, except where the Mine Safety and Health Act applies
	Agency for Toxic Substances and Disease Registry Control Standards for lead in soil	EPA has no promulgated human health standards for metals in soils. This remedial action uses 1,000 ppm lead in soil as an action level based on ATSDR recommendations for protection of human health in residential areas. This standard is to be considered in performing this remedial action.
	Land Use Restrictions, as insitutional controls	The State of Kansas will place restrictions on land use at the subsite to prevent any other activities, excavation, and any other activities that would compromise the integrity of the remedial actions
	20 CFR §§1910 et seq.	Regulates worker health and safety at hazardous waste sites during remedial actions. The regulation controls over OSHA or MSHA

1. The Safe Drinking Water Act (SDWA), 42 USC §300(g), the National Primary Drinking Water Standards, Maximum Contaminant Levels (MCLs) 40 CFR Part 141 and the Kansas Administrative Regulations 28-15-13 are relevant and appropriate for this remedial action. The ground water should be cleaned up in accordance with these requirements because the shallow ground water is a current and potential drinking water source. Although the MCLs are legally applicable standards promulgated for the protection of public drinking water supplies serving 25 or more people, the EPA believes these levels are relevant and appropriate cleanup goals for contaminated ground water where that water is currently or potentially a drinking water source. The levels established by the Kansas regulations are similarly relevant and appropriate. Table 8 identifies the MCLs established by the SDWA and the State of Kansas drinking water standards for heavy metal contaminants found in the shallow ground water at the subsite.

2. Secondary MCLs and MCL goals (MCLG) are to be considered in implementing this remedy. Secondary MCLs and MCLGs are not legally applicable standards for public drinking water supplies since they only provide for the protection of taste, odor and asthetic qualities. Since these are not health-based criteria, they are to be considered as necessary to remediate the ground water at the subsite. Secondary MCLs and MCLGs were published in 50 Federal Register 46936.

3. The Kansas Ground Water Cleanup Target Concentrations are to be considered in implementing this remedial action. These target concentrations for cleanup of ground water are nonpromulgated, but are standards used by KDHE for ground water remediation.

4. The Clean Water Act, 33 U.S.C. §1251 et seq., sets criteria for surface water quality based on toxicity to aquatic organisms and human health. The State of Kansas has similar water quality criteria and standards, see KAR 28-16-28 and the Ground Water Contaminant Cleanup Target Concentrations (relevant to ground water discharge via seeps and springs to surface waters). These laws and regulations are guidelines and are not legally applicable or enforceable requirements. However, these requirements are relevant to the protection of the environment at the subsite. The remedial action will monitor the surface water quality to measure the improvement in water quality and compare the results with these guidelines.

Location-Specific ARARs

The location-specific ARARs that will be attained by this remedial action are based on the location of the subsite and the affect of the hazardous substances on the subsite environment.

The following describes the location-specific ARARs listed in Table 9:

1. Executive Order 11988, Protection of Flood Plains (40 CFR 6, Appendix A) is a legally applicable requirement for this remedy. Portions of the subsite fall within the Spring River floodplain and therefore, the area is included within the scope of this executive order. The order applies to government actions. It requires that such actions avoid adverse effects, minimize potential harm to floodplains and restore and preserve the natural and beneficial values of floodplains, to the extent possible.

2. The Endangered Species Act, 16 U.S.C. Section 1531; 50 CFR Part 200; 30 CFR Part 402; and the Kansas Non-game and Endangered Species Conservation Act, KSA 32-501, are legally applicable requirements for this subsite. Several species of endangered or threatened salamander are found within the subsite and the requirements of these acts and regulations are applicable for the protection and conservation of these species. Consultation with the U.S. Department of Interior and the Kansas Fish and Game Commission are to be considered in implementing this remedy for the conservation of the endangered and/or threatened species and habitat found within the subsite.

3. Executive Order 11990, Protection of Wetlands, 40 CFR 6, Appendix A, is a legally applicable requirement for this remedy. This order requires the avoidance to the extent possible of adverse impacts associated with the destruction or loss of wetlands and to avoid construction in wetlands where practicable alternatives exist. Because some wetlands may be located within the subsite, this executive order is applicable, however, the selected remedy will not interfer with or impact wetlands. The selected remedy will be implemented with a preference toward filling all dry (non-flooded) shafts and subsidences which will minimize any loss of "artificial wetlands."

4. The Fish and Wildlife Coordination Act, 16 U.S.C. §661, 40 CFR 6.302 is a legally applicable requirement for this remedy. This requirement protects fish and wildlife from activities that might affect fish and wildlife habitat, such as diversion or channeling of a stream. The remedy includes channelization of streams in the subsite. Such action will be implemented in accordance with the substantive requirements of the Fish and Wildlife Coordination Act.

5. The National Historic Preservation Act, 16 U.S.C. §§470, *et seq*. and the regulation at 33 CFR Part 800 require that actions take into account possible effects on historic properties included on or eligible for the National Register of Historic Places. Since mining activities occurred over 100 years ago,

this requirement is to be considered in the implementation of this remedy in order to preserve possible historic property which may be encountered in the subsite. Certain mining property may remain in such condition that historic preservation may be desirable. When practicable, consideration should be given to proper historic preservation if such mining property is found during implementation of this remedy.

6. The National Archeological and Historic Preservation Act, 16 U.S.C. §469, and 36 CFR Part 65 require recovery and preservation of artifacts which may be discovered during government actions. This requirement is to be considered in the implementation of this remedy in order to preserve artifacts which may be found at the subsite. The remedial action includes removal and placement of surface mine wastes. This activity may reveal significant scientific, prehistorical, historical or archeological data. (For example, prehistorical Native American burial grounds and villages or historical mining camps, could be discovered although not likely.) Therefore when practical, consideration should be given to preservation if such artifacts are found during implementation of this remedy.

Action-Specific ARARs

The action-specific ARARs will be achieved by the selected remedy. These ARARs are based on activities and technologies to be implemented at the subsite. The following lists describe the action-specific ARARs shown in Table 10:

1. The Federal Mine Safety and Health Act, 30 U.S.C. §801, is a legally applicable requirement for this remedy. This act pertains to worker safety at mining operations. The remedial action includes removal of mine waste rock and chat and the filling of mine shafts, pits and subsidences. These activities are regulated to protect workers performing these actions.

2. The National Pollutant Discharge Elimination System, Effluent Limitations, 40 CFR Parts 122, 125 and 440 are relevant and appropriate limitations for this remedial action. The regulation at 40 CFR Part 440 sets technology-based effluent limitations for mine drainage from mining-related point sources. The remedial action includes the removal and processing of mine waste rock and chat. Such activities are sufficiently similar to mining and processing of lead and zinc ore that the effluent limitations are relevant and appropriate in the event that mine drainage is generated during the implementation of this remedy. Although the permitting requirements of the NPDES regulations are also relevant and appropriate, such permit is not required because this remedy will be conducted onsite, according to Section 121(e) of CERCLA, 42 U.S.C. Section 9621(e), no federal, state or local permit shall be required for any portion of a remedial action conducted entirely onsite.

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3. The Surface Mining Control and Reclamation Act, 30 U.S.C. §§1201, et seq., 30 CFR Part 816, Sections 816.56, 816.97, 816.106, 816.111, 816.116, 816.133 and 816.150 are to be considered in implementing this remedial action. These requirements provide guidelines for the post-mining rehabilitation and reclamation of surface mines. Although these requirements are not legally applicable nor relevant and appropriate for this remedial action, the activities that will be performed in implementing this remedial action are in some ways similar to mining reclamation. For example, the backfilling of shafts, pits and subsidences, protection of fish and wildlife during these activities, vegetation of the surface and post-mining land use and rehabilitation are all activities to be performed in this remedial action and are regulated under the Surface Mining Control and Reclamation Act.

4. Kansas regulations, KAR 28-30-1, for construction, reconstruction and plugging of water wells are legally applicable for this remedy. The selected remedy includes an investigation and, if necessary, reconstruction or plugging of deep water wells on the subsite to prevent migration of contaminated shallow ground water to the deep ground water.

5. Section 404 of the Clean Water Act, 33 U.S.C. §§1251 et seq. 40 CFR Parts 230 and 231 prohibits discharge of dredged or fill material into wetlands without a permit. The selected remedy calls for the filling of mine shafts and subsidences, with surface mine wastes. Some flooded subsidences may be considered "artifical wetlands" sufficiently similar to wetlands that the substantive requirements of Section 404 are relevant and appropriate for this remedy. However, a permit is not required because this action is conducted onsite entirely pursuant to Section 121(e) of CERCLA, 42 U.S.C. §9621(e).

6. Section 10 of the Rivers and Harbors Act, 33 U.S.C. §403, and related Regulations 33 CFR §§320, et seq., and Section 404 of the Clean Water Act, Regulations 40 CFR Part 125, Subpart M are relevant and appropriate requirements for this remedy. These requirements prohibit the disposal of dredged and fill material into streams without a permit. Because the remedy includes stream channelization, the substantive requirements of Section 404 are relevant and appropriate.

7. The Occupational Safety and Health Act (OSHA), 29 U.S.C. §§651 et seq., is legally applicable for this remedial action. This law regulates worker health and safety in the work place. It may overlap with requirements of the Mine Safety and Health Act (MSHA) and, if so, the MSHA is controlling. In addition, the occupation safety and health regulations found at 20 CFR §§1910 et seq., are legally applicable for this remedial action. These regulations protect health and safety of workers at hazardous

waste sites performing remedial actions. These regulations control whenever the OSHA or MSHA might overlap or conflict with these regulations.

8. The Centers for Disease Control (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR) have performed studies in residential areas to determine health-based levels of concern for exposure to lead contamination in soils. The health-based levels established by CDC and ATSDR are to be considered in implementing this remedy because EPA has no promulgated standards for heavy metals contamination in soil. The health-based levels to be considered for this action are 1,000 ppm lead and 25 ppm cadmium. Much of the mine waste rock and chat at the subsite contain heavy metals in excess of these health-based levels.

9. Deed restrictions are institutional controls that the State of Kansas and the local government will enforce to protect the construction of the remedial action. Restrictions to be considered in the implementation of this remedial action, include restrictions on future mining activities, water well construction, excavation of backfilled shafts and subsidences and other construction in the areas affected by this remedial action. The State of Kansas may consider establishing a Ground Water Management District program for the subsite to limit the use of shallow ground water for drinking water, pursuant to Kansas Administrative Regulations 28-30 and K.S.A. 82a-1036.

11.15 Overall Protection of Human Health and the Environment

This remedy protects human health by removing the exposed surface mine wastes that exceed the action level for lead from human contact and subsequent ingestion. Placement of the wastes below grade will effectively mitigate the potential for incidental ingestion. Since ingestion of surface mine waste represents the most significant exposure pathway for children, removal of the mine wastes will substantially protect the health of children.

Selective subsurface disposal of the surface mine wastes in conjunction with surface water channelization and recontouring should result in reduced metals loading in the ground water and surface water systems, but shallow ground water quality will continue to exceed contaminant-specific ARARs. The alternative water supply operable unit for the Galena subsite provides a suitable drinking water source to users who depend on the contaminated shallow ground water system.

Removal of the surface mine wastes and installation of lined diversion channels will significantly reduce the metals loading entering the surface waters through runoff and acid mine drainage from the waste piles. Over the long-term, surface water contamination will decrease. In addition, removal of the surface wastes will decrease the leaching of metals from these wastes and subsequent migration of the contaminants to the shallow ground water. Under this remedy, reductions in average concentrations of cadmium and zinc at the lower end of Short Creek will be experienced over the long-term. However, concentrations of both metals may continue to exceed chronic ambient water quality criteria.

The reductions in concentrations of cadmium and zinc in Short Creek may allow the existence of more diverse aquatic life species and larger numbers of individual aquatic organisms than presently occur; however, the stream may remain impaired. Loadings of cadmium and zinc to the Spring River will also be reduced because of the reduced loadings into Short Creek. Combined with remedial measures at other subsites, this may result in improved conditions in the vicinity of Baxter Springs near the downstream boundary of the Cherokee County site. This improvement may be achieved slowly due to long-term metals deposition in Short Creek, Spring River and Empire Lake (the sediments act as a source of contaminants).

The selected remedy will result in a reduction in metals loadings over the long term to the shallow ground water in the mine waste area. As a result of reducing direct leaching of mine wastes, this may have a positive impact on the private wells throughout the subsite; however, the extent of such an impact is difficult to predict and is expected to be minimal. There may be continued health risks associated with ingestion of the shallow ground water in the subsite.

In summary, the selected remedy will reduce the public health risks associated with the incidental ingestion of surface mine wastes and it will reduce the metals loadings in the surface water, which may improve the water quality for the benefit of aquatic life. The public health risks from ingestion of contaminated shallow ground water may not be significantly reduced under this remedy; however, the alternative water supply, as described in the Record of Decision of December 1987 for the Galena subsite, provides a remedy for this public health concern. The modeling results indicate that the selected remedy will reduce the concentration of zinc and cadmium downstream of the site. The reduction of metals in the surface water will have corresponding benefits to aquatic life. The selected remedy will practically eliminate the threat of metals contamination exposure through ingestion of surface mine wastes for the local population and will substantially reduce the health risks for children residing at the subsite.

The selected remedy also provides for protection of public health through remediation of the deep wells and boreholes. Remediation will protect against the migration of the contaminated water to the deep aquifer. The deep aquifer is used as the primary source of drinking water for many communities.

11.16 Community Acceptance

The community has shown a positive response to the preferred remedy presented at the August 3, 1989 public meeting. EPA's response to comments received from the public including those received from the potentially responsible parties are included in the Responsiveness Summary portion of this Record of Decision.

11.17 State Acceptance

The Kansas Department of Health and Environment has worked closely with the EPA in the review of the pertinent information and development of the selected remedy. A letter of concurrence on the selected remedy has been submitted by the State.

12.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

In the OUFS, EPA conducted a detailed analysis of each of the potential remedial alternatives, in accordance with the requirement of the NCP, 40 CFR Section 300.68(h). The analysis included: 1) Refinement of the feasibility of the alternative; 2) Detailed cost estimation, including operation and maintenance costs and distribution of cost over time; 3) Evaluation in terms of engineering, implementation, reliability and constructability; 4) An assessment of the extent to which the alternative effectively prevents, mitigates or minimizes threats to and provides adequate protection of public health and welfare and the environment; 5) An evaluation of the extent to which the alternative attains or exceeds applicable or relevant and appropriate federal and state public health and environmental requirements; 6) An analysis of whether recycle/reuse or other advanced, innovative or alternative technologies is appropriate; and 7) An analyses of any adverse environmental impacts.

The alternatives considered in the detailed evaluation were compared to CERCLA criteria for selection of the remedy as defined in Section 121 of CERCLA, 42 U.S.C. Section 9621 and EPA Office of Solid Waste and Emergency Response (OSWER) Directives 9355.0-19 and 9355.0-20. These remedy selection criteria include: 1) Implementability; 2) Reduction of toxicity, mobility or volume; 3) Short-term effectiveness; 4) Long-term effectiveness and permanence; 5) Cost; 6) Compliance with ARARs; 7) Overall protection of human health and the environment; 8) State acceptance; and 9) Community acceptance.

The 1988 OUFS provided a preliminary evaluation of twelve alternatives and detailed evaluation of five alternatives refined from the original twelve. These alternatives were evaluated based on the information available at the time. Subsequent to further modification of the five final alternatives and development of the 1988 preferred remedy, additional information was obtained. This information was obtained through investigations designed to clarify and promote development of viable remedial alternatives. The information received from these studies indicated that the containment alternatives and the 1988 preferred remedial alternative should be retained and reevaluated in the 1989 OUFS Supplement. The National Contingency Plan (NCP) requires that the no-action alternative be retained and evaluated throughout the Feasibility Study and remedy selection process. These alternatives and some new alternatives were then considered. Other alternatives considered in detail in the 1988 OUFS were not retained due to problems with effectiveness, implementability or cost. As a result, such alternatives are not discussed further.

For a detailed description of the analyses conducted, refer to the OUFS reports. The following section describes the evaluation criteria and summarizes the comparisons of surviving remedial alternatives for remedy selection. Table 11 provides a summary of the evaluation.

12.1 Implementability

The implementability criterion measures the difficulty associated with construction and operational reliability. It also evaluates the need for approvals and permits, time to implement, availability of equipment and specialists, availability of treatment, storage and disposal services and administrative concerns.

12.2 Reduction of Toxicity, Mobility or Volume

Section 121(b) of CERCLA, 42 U.S.C. Section 9621(b), states that remedial actions involving treatment, which permanently and significantly reduce the volume, mobility or toxicity of hazardous material are to be preferred over those not involving such treatment. This criterion requires a review of the treatment processes employed, the amount of materials destroyed or treated, the degree of expected reduction in toxicity, mobility or volume, the degree to which treatment is irreversible, and the hazards of the treatment residuals.

12.3 Short-Term Effectiveness

The short-term effectiveness criterion assesses how well an alternative provides for protection of the environment, community and workers during construction, the magnitude of reduction of existing risks, and the time required to achieve full protection.

Table 11
EVALUATION OF ALTERNATIVES

Criteria	Alternative 1 No Action	Alternative 2 Mine and Mill All Mine Wastes	Alternative 3 Mine and Mill All Mine Waste Rock and Half of the Chat	Alternative 4 Mine and Dispose of all Mine Wastes in Onsite Containment Facility	Alternative 5 Geochemically Characterize Wastes, Segregate by Size, Selectively Backfill, and Recontour
OVERALL PROTECTIVENESS					
Human Health Protection					
- Direct Contact/Mine Wastes Ingestion	Existing health threat from surface areas contaminated with lead greater than action level.	All contaminated surface solids above action level in disturbed areas removed.	All contaminated surface solids above action level in disturbed areas removed.	All contaminated surface solids above action level in disturbed areas removed.	All contaminated surface solids above action level in disturbed areas removed.
- Groundwater Ingestion	Primary drinking water standards exceeded. Alternate water supply for existing users being provided through other remedy.	Primary drinking water standards exceeded. Alternate water supply for existing users being provided through other remedy.	Primary drinking water standards exceeded. Alternate water supply for existing users being provided through other remedy.	Primary drinking water standards exceeded. Alternate water supply for existing users being provided through other remedy.	Primary drinking water standards exceeded. Alternate water supply for existing users being provided through other remedy.
Environmental Protection	Contaminated waters exceed AWQC in Short Creek and other surface waters.	Mass metal loads reduced but water quality still does not meet AWQC.	Mass metal loads reduced but water quality still does not meet AWQC.	Mass metal loads reduced but water quality still does not meet AWQC.	Mass metal loads reduced but water quality still does not meet AWQC.
COMPLIANCE WITH ARARS					
Chemical-Specific ARARs	No action does not meet chemical-specific ARARs.	Does not meet chemical-specific ARARs but will reduce mass metal loading.	Does not meet chemical-specific ARARs but will reduce mass metal loading.	Does not meet chemical-specific ARARs but will reduce mass metal loading.	Does not meet chemical-specific ARARs but will reduce mass mass metal loadings.
Location-Specific ARARs	Not relevant for no action.	Facilities designed to meet location-specific ARARs.	Facilities designed to meet location-specific ARARs.	Facilities designed to meet location-specific ARARs.	Facilities designed to meet location-specific ARARs.
Action-Specific ARARs	Action-specific ARARs are not relevant.	Mining and milling actions would be designed to comply with 30 USC 801-962. Milling plant would be designed and operated to meet appropriate NPDES discharge requirements including 40 CFR 440. The air emissions from the milling operation would be designed to meet the criteria of 40 CFR 61.	This alternative would have the same action-specific ARARs to be considered as for Alternative 2.	This alternative would need to consider RCRA design parameters for the containment unit.	This alternative would need to consider 30 USC 801-962 for actions around the shafts.
Other Criteria and Guidance	Would not protect human exposure to lead levels greater than action level in waste rock and chat.	All contaminated surface solids within disturbed areas exceeding lead action level removed.	All contaminated surface solids within disturbed areas exceeding lead action level removed.	All contaminated surface solids within disturbed areas exceeding lead action level removed.	All contaminated surface solids within disturbed areas exceeding lead action level removed.
LONG-TERM EFFECTIVENESS AND PERMANENCE					
Magnitude of Residual Risk	Mass metal loads not reduced.	Sulfate, zinc, and cadmium net mass loads reduced 27.6, 36.2, and 31.7%.	Sulfate, zinc, and cadmium net mass loads reduced 24.5, 33.2, and 29.4%.	Sulfate, zinc, and cadmium net mass loads reduced 27.6, 36.2, and 31.7%.	Sulfate, zinc, and cadmium net mass loads reduced 18.4, 29.5, and 25.6%.
- Mine Waste Ingestion	No long-term changes to current risk.	Alternative permanently removes ingestion risk from those areas where mine waste rock and chat are removed.	Alternative permanently removes ingestion risk from those areas where mine waste rock and chat are removed. Residual risk substantially reduced due to removal of metals in contaminated surface solids.	Residual risk reduced since level of metals in remaining surface solids less than action levels. Metal contaminants remain onsite.	Alternative removes ingestion risk from those areas where mine waste rock and chat are removed.

Table 11
(continued)

Criteria	Alternative 1 No Action	Alternative 2 Mine and Mill All Mine Wastes	Alternative 3 Mine and Mill All Mine Waste Rock and Half of the Chat	Alternative 4 Mine and Dispose of all Mine Wastes in Onsite Containment Facility	Alternative 5 Geochemically Characterize Wastes, Segregate by Size, Selectively Backfill, and Recontour
- Groundwater Ingestion	Primary drinking water standards continue to be exceeded in shallow groundwater. Alternate water supply (AWS) available for shallow groundwater users.	Metals mass loadings reduced; however, primary drinking water standards continue to be exceeded. AWS available for shallow groundwater users.	Metals mass loadings reduced; however, primary drinking water standards continue to be exceeded. AWS available for shallow groundwater users.	Metals mass loadings reduced; however, primary drinking water standards continue to be exceeded. AWS available for shallow groundwater users.	Metals mass loadings reduced; however, primary drinking water standards continue to be exceeded. AWS available for shallow groundwater users.
- Environmental Protection	AWQC exceeded in surface streams.	Metal mass loading reduced but AWQC still exceeded in surface streams.	Metal mass loading reduced but AWQC still exceeded in surface streams.	Metal mass loading reduced but AWQC still exceeded in surface streams.	Metal mass loading reduced but AWQC still exceeded in surface streams.
Adequacy and Reliability of Controls	No controls over contamination. No reliability.	Milling provides permanent removal; therefore, adequate and reliable. Stream diversions and revegetation actions provide some control of migration for remaining contaminants, though long-term O&M will be required. Long-term ground and surface water monitoring required to monitor effectiveness of controls.	Milling provides permanent removal; therefore, adequate and reliable. Stream diversions and revegetation actions provide some control of migration for remaining contaminants, though long-term O&M will be required. Long-term ground and surface water monitoring required to monitor effectiveness of controls.	Long-term adequacy and reliability expected to be high with long-term O&M. Stream diversions and revegetation actions provide some control of migration for remaining contaminants, though long-term O&M will be required. Long-term ground and surface water monitoring required to monitor effectiveness of controls.	Remedy adequately controls metal exposure for ingestion pathway. Stream diversions and revegetation actions provide some control for migration for remaining contaminants, though long-term O&M will be required. Long-term ground and surface water monitoring required to monitor effectiveness of controls.
Need for 5-year Review	A review at 5-year intervals will be needed to assess site conditions.	A review at 5-year intervals will be needed to assess site conditions.	A review at 5-year intervals will be needed to assess site conditions.	A review at 5-year intervals will be needed to assess site conditions.	A review at 5-year intervals will be needed to assess site conditions.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT					
Treatment Process Used	None.	Chat wet screening and milling and flotation of waste rock and chat fines.	Field XRF characterization and screening of chat exceeding action levels, milling and flotation of waste rock and chat fines.	None	Field characterization of chat and waste rock dry screening.
Amount Destroyed or Treated	None.	Would recover for potential resale about 85 percent of metals from processed waste rock and chat.	Would recover for potential resale 85 percent of metals from processed waste rock and chat.	None.	Treatment would separate geochemically active waste rock from less active waste rock.
Degree of Expected Reduction of Toxicity, Mobility, or Volume	None.	Reduction of mobility and volume of site contaminants will be achieved through the milling process for waste rock and chat. There is no reduction of toxicity.	Reduction of mobility and volume of site contaminants will be achieved through the milling process for waste rock and half of the chat. There is no reduction of toxicity.	Reduction of metal mobility will be achieved through containment. There would be no reduction in either toxicity or volume.	Reduction of metal mobility will be achieved through selective backfill of sized waste rock. There would be no reduction in either toxicity or volume.
Statutory preference for treatment	Does not meet this criterion because there is no treatment.	Utilizes milling process to remove the metals from the mine wastes and chat. This process is permanent and is considered to meet the statutory preference for innovative treatment as expressed in SARA.	Alternative 3 uses the basic processes as Alternative 2 for mine waste rock and the chat exceeding the action level.	This alternative uses no treatment processes. Mine waste rock and chat would be placed in a containment unit to minimize human exposure and leaching of metals to the shallow groundwater system. This alternative does not meet the statutory preference for treatment.	This alternative uses screening processes to isolate waste rock and chat containing metals levels above the action level.

Table 11
(continued)

Criteria	Alternative 1 No Action	Alternative 2 Mine and Mill All Mine Wastes	Alternative 3 Mine and Mill All Mine Waste Rock and Half of the Chat	Alternative 4 Mine and Dispose of all Mine Wastes in Onsite Containment Facility	Alternative 5 Geochemically Characterize Wastes, Segregate by Size, Selectively Backfill, and Recontour
Irreversible Treatment	Not applicable.	Milling and flotation are irreversible treatments.	Milling and flotation are irreversible treatments.	Not applicable.	Treatment not irreversible.
Type and Quantity of Residuals Remaining After Treatment	Mine waste rock and chat will continue to weather, releasing metals to ground and surface water.	Low levels of metals with concentrations less than action levels, remain in mill tailing.	No contaminated surface mine waste remains onsite.	Contaminated waste rock and chat will be contained onsite.	Contaminated waste rock and chat will be selectively isolated, controlling metal releases to the groundwater and human exposure.
SHORT-TERM EFFECTIVENESS					
Community Protection	Risk to community not increased by remedy implementation.	Temporary increase of dust production and truck traffic (haulage of waste rock and chat to mill).	Temporary increase of dust production and truck traffic (haulage of waste rock and chat to mill).	Temporary increase of dust production and truck traffic (haulage of waste to containment unit).	Minimal impact to community during implementation.
Worker Protection	No risk to workers.	Protection from dust exposure and dermal contact will be required. Workers must be cautious concerning unstable ground conditions.	Protection from dust exposure and dermal contact will be required. Workers must be cautious concerning unstable ground conditions.	Protection from dust exposure and dermal contact will be required. Workers must be cautious concerning unstable ground conditions.	Protection from dust exposure and dermal contact will be required. Workers must be cautious concerning unstable ground conditions.
Environmental Impacts	Continued impact from existing conditions.	As mine waste rock is removed, contaminant mass load will decrease.	As mine waste rock is removed, contaminant mass load will decrease.	As mine waste rock is removed, contaminant mass load will decrease.	Minimal impact to environment during implementation.
Time until Action is Complete	Not applicable.	3-1/2 to 4 years.	3 to 3-1/2 years.	About 1 year.	About 2-1/2 years.
IMPLEMENTABILITY					
Ability to Construct/Operate Technology	Not applicable.	Conventional recovery, transport, and beneficiation technologies are easily implementable. However, enhanced recovery to meet action level requires innovative technologies. Rechanneling, recontouring, revegetation, and well remediation are all conventional technologies that should be easy to implement.	Conventional recovery, transport, and beneficiation technologies are easily implementable. However, enhanced recovery to meet action level requires innovative technologies. Innovative use of XRF technology will provide characterization of chat. Rechanneling, recontouring, revegetation, and well remediation are all conventional technologies that should be easy to implement.	Containment technology easy to implement. Construction materials would have to be hauled to site. Rechanneling, recontouring, revegetation, and well remediation are all conventional technologies that should be easy to implement.	Innovative use of XRF technology will provide characterization of chat. Sizing process for waste rock segregation is standard technology hence easily implementable. Isolation of contaminated materials employs conventional earthmoving technologies. Rechanneling, recontouring, revegetation, and well remediation are all conventional technologies that should be easy to implement.
Reliability of the Technology	Not applicable.	Reliability of treatment process requires monitoring of feed and tailing product quality. The reliability of the recontouring, channelization, revegetation, and well remediation will depend on routine maintenance.	Reliability of treatment process requires monitoring of feed and tailing product quality. Reliability of the chat XRF characterization operations will be controlled through detailed procedures. The reliability of the recontouring, channelization, revegetation, and well remediation will depend on routine maintenance.	Containment unit would be constructed to have high operational reliability. Reliability of the chat XRF characterization operations would be controlled through detailed procedures. The reliability of the recontouring, channelizational revegetation, and well remediation will depend on routine maintenance.	Earthmoving technologies are reliable. Reliability of the chat XRF characterization operations will be controlled through detailed procedures. The reliability of the recontouring, channelization, revegetation, and well remediation will depend on routine maintenance.
Ease of Doing More Action if Needed	Not applicable.	Alternative removes and treats all surface mine wastes.	Additional chat could be removed.	Wastes could be later retrieved for treatment or other disposal.	Additional actions very difficult.

Table 11
(continued)

Criteria	Alternative 1 No Action	Alternative 2 Mine and Mill All Mine Wastes	Alternative 3 Mine and Mill All Mine Waste Rock and Half of the Chat	Alternative 4 Mine and Dispose of all Mine Wastes in Onsite Containment Facility	Alternative 5 Geochemically Characterize Wastes, Segregate by Size, Selectively Backfill, and Recontour
Ability to Monitor Effectiveness	Preremediation baseline water quality well documented.	Monitoring of shallow groundwater and surface water will provide measure of remedy effectiveness.	Monitoring of shallow groundwater and surface water will provide measure of remedy effectiveness.	Monitoring of shallow groundwater and surface water will provide measure of remedy effectiveness.	Monitoring of shallow groundwater and surface water will provide measure of remedy effectiveness.
Ability to Obtain Approvals/ Coordination with Agencies	Not applicable.	Property access must be obtained. Regulatory approval should be easily obtained.	Property access must be obtained. Regulatory approval should be easily obtained.	Property access must be obtained. Regulatory approval should be easily obtained.	Property access must be obtained. Regulatory approval should be easily obtained.
Availability of Services and Capacities	No services or capacities required.	Services and capacities easily obtainable.	Services and capacities easily obtainable.	Services and capabilities easily obtainable.	Services and capacities easily obtainable.
Availability of Equipment, Specialists, and Materials	None required.	Readily available.	Readily available.	Readily available.	Readily available.
Technology Availability	None required.	Oxide mineral flotation stage will require pilot testing for expected wide range of mine waste mineralogical variability and content. Rechannelization, revegetation, and well remediation are all readily available technologies.	Oxide mineral flotation stage will require pilot testing for expected wide range of mine waste mineralogical variability and content. Waste characterization with XRF technology will require development of standard procedures. Rechannelization, revegetation, and well remediation are all readily available technologies.	Containment technology is readily available. Rechannelization, revegetation, and well remediation are all readily available technologies.	Earthmoving and sizing technologies are readily available. Rechannelization, revegetation, and well remediation are all readily available technologies. Waste characterization with XRF technology will require development of standard procedures.
COST					
Capital Cost	$0	$20,302,000	$18,400,000	$29,378,800	$8,295,200
First Year Annual O&M Cost	$0	$3,830	$3,830	$222,350	$14,960
Present Worth Cost	$0	$20,737,000	$18,834,300	$33,172,400	$8,900,800

12.4 Long-Term Effectiveness and Permanence

Alternatives are assessed for the long-term effectiveness and permanence they afford along with the degree of certainty that the remedy will prove successful. Pursuant to this criterion, the magnitude of residual risks following implementation, type and degree of long-term management required, potential of human and environmental exposure to the remaining wastes, long-term reliability of the controls and the potential need for replacement of the remedy are assessed.

12.5 Cost

The cost criterion includes capital costs, operation and maintenance costs, costs of five-year reviews, net percent value of capital and O&M costs and potential future remedial action costs.

12.6 Compliance with ARARs

Section 121(d) of CERCLA, 42 U.S.C. Section 9621(d), requires that remedial actions shall attain a degree of cleanup of hazardous substances released into the environment and a degree of control over further release that at a minimum assures protection of human health and the environment. It requires that any Federal or State law, standard, requirement, criteria or limitation which is legally applicable to the hazardous substance or is relevant and appropriate under the circumstances shall be the level or standard of control for such hazardous substance or contaminant remaining at the site. The applicable or relevant and appropriate requirements (ARARs) for remedial alternatives at this subsite include contaminant-specific ARARs, location-specific ARARs and action-specific ARARs.

12.7 Overall Protection of Human Health and the Environment

This criterion is used to assess the alternatives from the standpoint of whether they provide adequate protection of human health and the environment.

12.8 State and Community Acceptance

The state and community acceptance criterion is used to assess support and opposition to the components of the alternatives provided at the state government and local community level.

13.0 SELECTED REMEDY

13.1 Purpose of Action

The selected remedy for the ground water/surface water operable unit and the remedy for the alternative water supply operable unit will address the public health and environmental concerns at the Galena subsite. The ground water/surface water action will remove the public health risk from incidental ingestion of the surface mine wastes. The action will reduce the mobility of the surface and subsurface contaminants which affect the ground water and surface water. The action will reduce the metals loadings on the surface streams. The alternative water supply operable unit will eliminate the public health risk associated with drinking the contaminated shallow ground water.

13.2 Rationale for Preference

The selected remedy was chosen because it meets the long-term goals (other than the Safe Drinking Water Act MCLs and Ambient Water Quality Criteria) for the project, is protective of the public health and environment, is cost effective and meets the preference for the use of permanent solutions to the maximum extent practicable in accordance with Section 121 of CERCLA, 42 U.S.C. §9621. The selected remedy's provision for placement of surface mine wastes which contain lead above the action level below a recontoured ground surface and a compacted and vegetated cover is a permanent solution. This action will eliminate the public health threat previously posed by those wastes from incidental ingestion. The remedial component of screening the surface mine wastes and selective placement on a geochemical basis of these wastes below grade provides a process that renders the metals less mobile.

Although the selected remedy does not use treatment or resource recovery, it is just as protective and achieves similar remediation of the subsite as the 1988 preferred remedy which was a treatment and resource recovery alternative. However, the 1988 preferred remedy was estimated to cost 2.5 times more than the selected remedy. Therefore, treatment and resource recovery alternatives are not practical remedies for this subsite.

Although the other alternatives analyzed in the OUFS may provide some of the same improvements as the selected remedy, the following deficiencies in these other alternatives provide a rationale for implementation of the selected remedy:

No Action

- The no-action alternative fails to address public health risks due to incidental ingestion of surface mine wastes;

- The no-action alternative fails to address any improvement in surface water or ground water quality (shallow or deep aquifers); and

- The no-action alternative fails to reduce mobility, volume or toxicity of hazardous substances at the site.

Alternative 2 - 1989 OUFS Supplement

- Alternative 2 obtains the same level of protection for the public health risk due to incidental ingestion of surface mine waste, however, the costs are nearly 2.5 times as expensive as the selected remedy.

- Although Alternative 2 does achieve greater improvement in the surface water quality compared to the selected remedy, it still does not meet contaminant-specific ARARs. Thus, the greater costs are not justified.

Alternative 3 - 1989 OUFS Supplement

- Alternative 3 obtains the same level of protection for the public health risk due to incidental ingestion of surface mine waste, however, the costs are nearly 2.0 times as expensive as the selected remedy.

- Although Alternative 3 does achieve greater improvement in the surface water quality compared to the selected remedy, it still does not meet contaminant-specific ARARs. Thus, the greater costs are not justified.

Alternative 4 - 1989 OUFS Supplement

- Alternative 4 achieves the same level of protection for public health, however, the costs are greater than 3.5 times as expensive as the selected remedy.

- Alternative 4 achieves a greater improvement in the surface water quality, however, it still does not meet the contaminant-specific ARARs, thus the greater cost remain unjustified.

- Alternative 4 would be difficult to implement due to anticipated problems in finding a location for a single unit to contain all waste material.

- Alternative 4 is unacceptable to the state.

In general, the selected remedy was chosen for implementation on the basis of the remedy selection criterion and the evaluation of various alternatives according to the NCP requirements, to the maximum extent practicable.

13.3 Compliance with ARARs

Under Section 121(d) of CERCLA, 42 U.S.C. Section 9621(d), remedial actions must attain a degree of cleanup that assures protection of human health and the environment. Additionally, Superfund remedial actions that leave any hazardous substance, pollutant or contaminant onsite must meet, upon completion of the remedial action, a level or standard of control that at least attains standards, requirements, limitations or criteria that are "applicable or relevant and appropriate" under the circumstances of the release. The ARARs that have been identified for the selected remedy are presented on Tables 8, 9 and 10 hereinabove. The location- and action-specific ARARs will be achieved.

13.4 The Selected Remedy Does Not Achieve Chemical-Specific ARARs

According to Section 121(d) of CERCLA 42 U.S.C. Section 9621(d), a remedial action that does not attain ARARs may be selected if it attains a degree of cleanup of hazardous substances, pollutants and contaminants released into the environment and control of further releases which, at a minimum, assures protection of human health and the environment. Such a remedial action is allowed if any one of the following conditions occurs:

(A) The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed;

(B) Compliance with such requirement at that facility will result in greater risk to human health and the environment than alternative options;

(C) Compliance with such requirements is technically impracticable from an engineering perspective;

(D) The remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria or limitation through use of another method or approach;

(E) With respect to a state standard, requirement, criteria or limitation, the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criteria or limitation in similar circumstances at other remedial actions within the state; or

(F) In the case of a remedial action to be undertaken solely under Section 104 of CERCLA, 42 U.S.C., Section 9604, using the Fund, selection of a remedial action that attains such level or standard of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration and the availability of amounts from the Fund to respond to other sites which present or may present a threat to public health or welfare or the environment, taking into consideration the relative immediacy of such threats. Where any of the above conditions occur and ARARs cannot be achieved by the selected remedy, EPA may "waive" the specific ARARs.

The selected remedy will not meet the contaminant-specific ARARs for the ground water and surface water. These ARARs include attaining the MCLs in the ground water and the AWQC in the surface water and the equivalent state standards. The selected remedy will not attain these ARARs due to technical impracticability as described above in condition (C). It is technically impracticable to meet the ARARs because of the continued presence of waste materials remaining onsite and contaminants offsite and upgradient of the Galena subsite. Consistently, Short Creek exceeds standards at the point where it enters the subsite and at times, the Spring River exceeds standards at the point where it enters the site.

In the initial screening of alternatives, EPA considered whether any alternative exists which would achieve contaminant-specific ARARs. The only technology that possibly would remediate the site to achieve these ARARs is to treat all surface mine wastes and strip mine the remaining mineralization in the Galena subsite. This alternative has several implications on the environment and human health, including, but not limited to, destruction of an endangered species habitat, removal of all surface soils and permanent relocation of the town of Galena. The EPA also concluded that the costs of such an alternative could exceed the available funds in the Hazardous Substance Superfund. Finally, even with this alternative, it could not be accurately predicted whether contaminant-specific ARARs would be achieved because it may not be possible to completely remove all the mineralization. In addition, upgradient sources of contamination may continue to degrade water quality within the Galena subsite.

13.5 Monitoring of Selected Remedy

The surface water quality will be monitored on Short Creek approximately one mile upgradient of the Spring River to determine the actual effectiveness of the remedial action. The frequency of the monitoring will be determined during remedial design. It is currently anticipated that ground water and surface water monitoring will be conducted during the remedial action and at five-year intervals thereafter. Following the implementation of the remedial action, the effectiveness of the remedial action will be evaluated every five years, as necessary, as required by Section 121(c) of CERCLA, 42 U.S.C. Section 9621(c).

14.0 STATUTORY DETERMINATIONS

The selected remedy satisfies the statutory requirements for the degree of cleanup as specified by CERCLA. Section 121 of CERCLA, 42 USC Section 9621, states that the selected remedy must:

1) Be protective of human health and the environment;

2) Attain ARARs (or provide evidence showing ARARs cannot be attained);

3) Be cost-effective; and

4) Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

14.1 Protection of Human Health & the Environment

The selected remedy removes and selectively places the surface mine wastes below grade in subsite mine voids and recontours and vegetates portions of the land surface to eliminate the public health risk of incidental ingestion of the mine wastes. The selective placement of surface mine wastes, recontouring and vegetation reduces the infiltration of the metals into the shallow ground water. The stream diversions and channelization along with the other cited actions, will improve the stream water quality. These actions improve the quality of runoff from the mined areas and reduce the contaminated shallow ground water discharged to the streams. In addition, the time to implement this remedy is much shorter than the 1988 preferred remedy (two years vs four years) and thus, will provide this protection of the public health and environment much sooner. The deep well remediation, if needed, will be protective of the Roubidoux aquifer.

14.2 Attainment of the ARARs

The selected remedy will reduce the metal contaminants in the surface water and the shallow ground water, but will not attain the contaminant-specific ARARs for those two media. The remedy will be engineered and implemented to meet location-specific and action-specific ARARs.

Following implementation of the action, the metals contaminants in the shallow ground water will continue to exceed maximum contaminant levels as set by the Safe Drinking Water Act and the equivalent state standards. The surface water will continue to exceed ambient water quality criteria for the protection of aquatic life as set by the Clean Water Act and the equivalent state standards. Implementation of an action in an attempt to meet these ARARs would present a greater risk to the environment than currently exists and than will exist under the selected remedy. In addition, it is technically impractical to implement an action to meet ARARs at this subsite. Tables 8 and 9 on location-specific and action-specific ARAR's, presented in Section 11 herein, document the ARARs which will be attained by the selected remedy.

All activities of the selected remedy will be conducted onsite and, therefore, permits are not required according to Section 121(e) of CERCLA, 42 U.S.C. Section 9621(e). Coordination will be conducted with Kansas agencies, other Federal agencies and EPA programs.

Cost Effectiveness

The selected remedy is cost-effective. It provides overall effectiveness proportional to its costs such that the remedy represents a reasonable benefit for the cost expenditures. In conjunction with the alternative water supply operable unit, the selected remedy will substantially mitigate the public health threats identified at the subsite. The selected remedy will provide a reduction in the contaminants of concern in the stream water which will improve surface water quality. This alternative also provides protection to the Roubidoux aquifer, the regional drinking water source. The selected remedy provides less protection to the environment than some of the other alternatives evaluated, but provides equal or better protection to the public health. The selected remedy is less expensive than the other alternatives evaluated.

Utilization of Permanent Solutions

The selected remedial action of screening the mine waste rock and selectively placing that material below grade based on its geochemical character provides a solution that permanently removes the surface mine wastes from the surface. The wastes after placement will not be removed from the mine voids.

RESPONSIVENESS SUMMARY
Record of Decision
for the
Ground Water/Surface Water Operable Unit
Galena Subsite, Cherokee County

INTRODUCTION

This Responsiveness Summary presents responses of the Environmental Protection Agency (EPA) to public comments received regarding remedial actions for the ground water/surface water operable unit at the Galena subsite in Cherokee County. This document addresses significant comments received by the Agency during the two comment periods held during the remedy selection process.

The EPA and Kansas Department of Health and Environment (KDHE) have developed and selected an operable unit remedy to remediate the ground water/surface water at the Galena subsite in Cherokee County. The selected remedy and other potential alternatives were evaluated in an operable unit feasibility study (OUFS). The OUFS considered the available information pertinent to improvement of the ground water and surface water quality and protection of the Roubidoux aquifer. The OUFS is comprised of the March 1988 OUFS and July 1989 OUFS Supplement.

A public meeting was held on August 3, 1989 to present the preferred remedy to the public and to receive comment. A public comment period was open from July 25 to August 28, 1989. A notice was published in the Joplin Globe and Galena Sentinel, which announced the public comment period and the availability of the Proposed Plan, OUFS Supplement and updated Administrative Record.

A Proposed Plan was also developed in 1988 in conjunction with the 1988 OUFS. This Proposed Plan outlined the preferred remedy that was presented to the public at a meeting on February 28, 1988. The EPA provided a public comment period between March 7 and April 29, 1988, for comment to the 1988 Proposed Plan and 1988 OUFS. Notice of the February 1988 public meeting and public comment period was published in the Joplin Globe.

This Responsiveness Summary will address comments received during both of the above described comment periods. Part 1 will address those comments received to the 1988 Proposed Plan. In addition, Part 1 will address comments received from a potentially responsible party (PRP) group to the Alternative Water Supply OUFS at their request. Part 2 will address those comments received to the 1989 Proposed Plan. Both parts provide responses to comments received from the public, including city, state and federal officials and agencies and PRPs.

I. Comments to the 1988 Proposed Plan

Responses to comments received between March 7 and April 29, 1988, give the Agency's perspective on the issues at the time the comments were received. In addition, the responses provide the Agency's current perspective as affected by the 1988 remedy selection process and details of the selected remedy.

A. Comments from the Public

1. Comment: Two commenters express concern about the metals uptake of plants. One of the commenters is concerned about current vegetable gardens. The other is concerned about the area to be revegetated in the project. The later commenter suggests that special soil treatment to fixate the metals should be used or land use restrictions for those areas should be established.

Response: The EPA will conduct activities that place mine wastes containing metals at levels of concern below the ground surface under a vegetated cover. Plants can uptake metals from the soil and water. Specific rates of uptake or levels of metals in area plants is not available. The selected remedy will remove the mine wastes from the surface, which act as a source of metals. This action over the long term will decrease the exposure to area plants. During the design of this action a determination will be made on the type of vegetation to be used. The State of Kansas or local government will be responsible for providing all land use restrictions after the area has been recontoured and revegetated, to assure future integrity of the cover.

2. Comment: A commenter questions if the project includes stabilization of areas where the chat piles have already been removed.

Response: Areas where chat piles have been removed will be stabilized if there are significant quantities of surface mine wastes remaining in close proximity. Those areas included for stabilization will be delineated during the remedial design. The areas within the Galena subsite in close proximity with the remaining surface waste accumulations where chat piles have been removed will be stabilized by compacting filled areas and recontouring and revegetating the cover material.

3. Comment: A commenter suggested that we should mix four parts waste rock with one part concrete and use the mixture to line the stream bed. The commenter stated that $3,537,500 would be needed for the concrete to bind up all the waste rock. He stated that the need for a mill would be eliminated with his suggested plan.

Response: Use of the mine wastes for lining the streams is of concern because the metals could leach out of the concrete if not properly maintained and continue to present a health threat. The type of concrete mix and proportion of ingredients to be used will be determined during the design phase.

4. Comment: A commenter stated that a strategy should be developed to evaluate the improvements in aquatic habitat as the result of the remediation.

Response: The EPA agrees with the commenter and will develop a plan to monitor the improvements. The plan will be developed during the design activities.

5. Comment: A commenter indicated that it would be good to fill in subsidences and visible rooms.

Response: The EPA agrees with the commenter in part. Some subsidences will be filled as a part of the remedial action. The filling will be conducted in a manner that promotes proper drainage and prevents erosion.

6. Comment: The commenter asked if we planned to fill shafts. He said that the shafts he has backfilled that do not connect to drifts are successful. The commenter also stated that fill placed in shafts that connect to drifts settle and are not successful.

Response: The EPA understands the problem and is intending to fill as many mine voids, pits, shafts, subsidences open to the surface as possible. The affected shafts will be covered, and recontoured and vegetated to the extent possible. Details of this activity will be clarified during the remedial design phase.

B. Comments from the PRPs Received During the 1988 Public

1. Comment: Some commenters suggested EPA's 1988 proposed remedial action at the site was intended to cleanup the ground water/surface water (GW/SW) beyond the quality of the water in its premining condition.

Response: The EPA's proposed remedial action in 1988 for ground water/surface water cleanup at the Galena subsite was proposed on the basis of achieving protection of human health and the environment and the requirements of the Comprehensive Environmental Response, Compensation and Liability Act of 1980

(CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 USC Section 9601 et seq, and the National Contingency Plan (NCP). The EPA determines appropriate cleanup standards for water on the basis of potential uses for the water. The degree of cleanup is determined in accordance with Section 121(d) of CERCLA, 42 U.S.C. Section 9621(d).

The shallow ground water aquifer subject to remedial action is used directly for drinking water (without treatment) and may continue to be utilized directly for such purposes. The applicable or relevant and appropriate cleanup standards for such waters are the Maximum Contaminant Levels (MCL) established pursuant to the Safe Drinking Water Act (SDWA). These same cleanup levels, along with additional standards, are implemented by the State of Kansas through the Kansas Ground Water Contaminant Cleanup Target Concentrations. These Kansas Action Levels (KAL) apply to all fresh and usable aquifers and are "applicable" for the Galena subsite remedial action. The surface water subject to remedial action is and may continue to be used for aquatic life and recreational purposes. According to Section 121(d) of CERCLA, the applicable or relevant and appropriate cleanup standards for such surface waters include, but are not limited to, the Federal Ambient Water Quality Criteria for the protection of aquatic life and the Kansas Surface Water Quality Standards.

Although EPA acknowledges that hazardous substances may have been released into the ground water and surface water in the Galena subsite from the presence of the natural ore prior to mining activities, EPA has no conclusive evidence that the water quality exceeded the SDWA standards in its premining condition. On the basis of best scientific judgment, the EPA believes that the mining activities exacerbated the release of hazardous substances into the ground water and surface water because the mining activities significantly altered the hydrogeology of the Galena subsite, and the surface mine wastes left by miners contributes to the formation of acid mine drainage which continues to degrade the water quality of the subsite.

2. Comment: The commenters state that the Federal Ambient Water Quality Criteria, Kansas Surface Water Quality Standards, the Safe Drinking Water Act MCLs and the Kansas KALs are not legally applicable or relevant and appropriate requirements (ARARs) for the ground water/surface water remediation at the Galena subsite.

Response: According to Section 121(d) of CERCLA, 42 U.S.C. §9621(d), the remedy selection process requires consideration of cleanup levels for remediation of Superfund sites where any hazardous substances remain onsite at completion of the response action. The AWQC, MCLs, and KALs are ARARs for the ground water/surface water remediation due to the uses and potential uses of the shallow ground water for drinking water, agricultural and aquatic life. The surface water is the habitat for a variety of aquatic life; for example the Spring River Basin is a critical habitat for the Eurycea multiplicata griseogaster, a species of graybelly salamander, a Kansas endangered species.

3. Comment: The commenters suggest that a variance from KALs is appropriate because contamination at the site is due to "natural pollution".

Response: The Kansas Surface Water Quality standards recognize that naturally occurring minerals may result in "natural pollution" of surface waters and in such situations a variance from the Kansas standards may be secured, KAR 28-16-28(c)(3). However, the Kansas variance procedure is inappropriate for the Galena subsite. Contamination from the Galena subsite is inconsistent with the Kansas definition of "natural; being in a state of nature untouched by influences of civilization and society," KAR 28-16-28(c). Since mining activities influenced and touched the ore body, the contamination cannot be the result of "natural pollution" in accordance with the Kansas definition.

4. Comment: The commenters state that the long-term goals for the subsite are inappropriate. They believe that achieving the long-term goals will result in conditions better than the naturally occurring conditions. They state that such long-term goals are arbitrary and capricious and, therefore, unlawful and outside of the scope of CERCLA.

Response: The long-term goals for the ground water/surface water remediation at the Galena subsite include: 1) Protect the

Roubidoux aquifer from contaminant inflows, 2) Protect human health of the population from mining-related contaminants in the ground water and surface water systems and in the surface mine wastes, 3) Meet Kansas Ground Water Contaminant Cleanup Target Concentrations (Note: These include the Maximum Contaminant Levels established by the Safe Drinking Water Act) in the ground water and 4) Meet both Federal Ambient Water Quality Criteria (AWQC) and Kansas Ambient Water Quality Criteria (Kansas Surface Water Quality Standards) in surface streams.

The first long-term goal is appropriate for the subsite because EPA has determined that the Roubidoux aquifer is threatened by contaminant inflows from the shallow aquifer. The Roubidoux aquifer is used as the water source for several public water supplies in the Cherokee County area. The contamination may occur through deep wells or boreholes. Improperly cased or corroded wells and uncased boreholes that penetrate the contaminated shallow aquifer and the deep aquifer could allow the migration of the contaminants from the shallow aquifer to the Roubidoux aquifer. Contaminant migration also may occur through potentially permeable rock layers separating the shallow and deep aquifers. Although the EPA believes the rock layers between the aquifers are generally impermeable, some scientists have indicated that shallow ground water may reach the deep aquifer through voids or fractures in the impermeable rock layers. On the basis of these potential contaminant pathways and the use of the aquifer for a public water supply, EPA developed this long-term goal for the subsite that the Roubidoux aquifer should be protected from contaminant inflows from the shallow aquifer.

The second long-term goal is appropriate for the subsite because EPA has determined that public health is threatened by contamination present in the ground water and surface water at the subsite. The feasibility study for the ground water and surface water remediation at the Galena subsite provides a health assessment on the basis of the "no action" alternative for remediation at the Galena subsite. This health assessment demonstrates the threat of chronic health effects on the exposed population due to the contamination in the ground water and surface water at the Galena subsite. The risks are based on exposure to the contaminants through ingestion of the ground water and incidential ingestion and absorption through the skin during swimming activities. The data and conclusions of the RI and the feasibility study for the Galena subsite support EPA's decision to evaluate remedial alternatives for achievement of the protection of human health from the contamination in the ground water/surface water at the subsite. The health assessment also showed an additional potential chronic health effect due to ingestion of the contaminants in the mine wastes.

The third and fourth long-term goals are appropriate because EPA has determined in accordance with Section 121 (d) of CERCLA, 42 USC Section 9621 (d), that the stated standards for cleanup at the subsite are applicable or relevant and appropriate. This determination is based on: (1) the current and potential uses for the ground water, which includes water for both drinking and agricultural purposes; and (2) the protection of aquatic life and human health from exposure to the surface water contaminants. Additional explanation as to the appropriateness of these goals is found in the aforementioned comments and responses.

As shown, the long-term goals are based on the requirements of CERCLA and are reasonable for the subsite. These goals are not inappropriate nor arbitrary and capricious. These goals have been developed in light of the cleanup standards of Section 121 (d) of CERCLA, 42 USC 9621 (d), and are well within the scope of CERCLA.

5. Comment: The commenters believe the short-term goals are inappropriate, arbitrary and capricious, and outside the scope of CERCLA because they are vague and do not meet ARARs.

Response: The short-term goals were developed during the feasibility studies for remediation of the Galena subsite. In the OUFS, EPA determined that certain long-term goals for the ground water and surface water remediation are technically impracticable, i.e., the goals of meeting KALs in the ground water and AWQCs in the surface water. Yet, EPA and KDHE scientists and engineers also determined that by controlling the source of the contamination and the hydrology, various degrees of contaminant reduction could be achieved over a period of time by a gradual flushing of the ground water and surface water systems. Although EPA does not have data demonstrating the length of time required before this gradual flushing would clean the ground

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water and surface water system to meet the KALs and AWQCs, the theory is based on sound hydrogeologic principles and best engineering judgment. The EPA, therefore, believes the short-term goals are rational, appropriate and based on sound reasoning.

The short-term and long-term goals were determined to be appropriate by following EPA's decision-making procedures, which include: development of the goals by the EPA Remedial Project Manager, KDHE staff and technical consultants, then review of these goals by EPA Regional Counsel and EPA and KDHE management. The EPA management decides, on the basis of scientific and legal advise, the appropriateness of the goals for the site conditions. In this case, these short-term goals and the previously described long-term goals were determined to be appropriate. The commenters' suggestion that such goals are arbitrary and capricious is without merit and directly contrary to the sound reasoning and decision-making procedures utilized in developing and determining the long-term and short-term goals.

The same commenters suggest that the short-term goals are outside the scope of CERCLA and reference Section 104(a)(3)(A) of CERCLA, 42 USC §9604(a)(3)(A), which states that:

> "The President shall not provide for a removal or remedial action under this section in response to a release or threat of release -
>
> (A) of a naturally occurring substance in its unaltered form or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found;..."

As discussed previously in this responsiveness summary, the selected remedial action will remediate the ground water and surface water systems within the Galena subsite which are contaminated as a direct result of mining activities. These mining activities significantly altered the natural hydrogeology of the subsite so as to cause a release of hazardous substances within the subsite. The President has authority according to Section 104 of CERCLA to respond to releases or threatened releases of hazardous substances at a site. The exception cited in Section 104(a)(3)(A) of CERCLA is not applicable for the Galena subsite due to the mining activities which significantly altered the natural conditions at the subsite, although prior to the mining activities some naturally occurring hazardous substances may have been released at the subsite, the mining activities altered the natural conditions and exacerbated and accelerated the release of hazardous substances to the ground and surface waters.

6. Comment: The commenters express concern that EPA believes the mining activities are the sole cause for the contamination.

Response: As was acknowledged in the OUFS and previously in this responsiveness summary, EPA suspects that the levels of heavy metal contaminants identified in the ground and surface waters may include contaminants from other sources, such as unmined ore. The Agency estimates that the surface mine wastes contribute over 26 percent of the cadmium, zinc and sulfate contamination in Short Creek. The levels of lead contamination in Short Creek from the surface mine wastes may be higher, but are difficult to estimate. Other sources of contamination include, but may not be limited to, upstream mining areas, mining wastes found inside mine voids and subsidences and unmined ore exposed to oxygenated water within old mining tunnels and rooms.

7. Comment: The commenters state that EPA failed to consider that the mining activities have removed a large amount of mineralized naturally occurring materials.

Response: The EPA is conducting a response at the site based on the release or threat of release of contaminants presently found at the site.

8. Comment: The commenters thought EPA should qualify pre-mining conditions and base the project goals on the findings. They cite a letter from KDHE where KDHE also suggested defining background conditions.

Response: The EPA considered investigating the premining background condition, but did not pursue it because such an investigation is costly, time consuming and yields only hypothetical results. Instead, EPA and KDHE determined it would be appropriate to set goals to improve the current conditions (which present a health threat). The commenters tried to establish background conditions at the site, but were unable to do so. Since mining activities commenced in 1876 at the subsite, no water quality records are available of the pre-mining water conditions. The commenters concluded in their investigation that there may have been elevated concentrations of metallic ions in Short Creek and shallow ground water system in pre-mining time. A review of the commenters report on background conditions is provided in the administrative record.

9. Comment: The commenters believe EPA is obligated to reevaluate its position concerning the effect of mining on water quality and EPA's fundamental approach to the goals, objectives and targets for any remedial actions at the subsite or site.

Response: As expressed earlier in this responsiveness summary, EPA's decision to proceed with remedial action is based on the need to protect human health and the environment and the release or threatened release of hazardous substances at this subsite. The goals, objectives and targets are reasonable for the subsite and site.

10. Comment: The commenters disagreed with the approach used in the public health assessment in the feasibility study report.

Response: The public health assessment was conducted for the no-action alternative at the site using the methodology established in the EPA guidance documents, the Superfund Public Health Evaluation Manual and the Superfund Exposure Assessment Manual. The EPA methods require evaluation of the worst case exposure situations. The commenters do not believe worst case scenarios should be evaluated. The commenters indicate that all the individual sources of contaminants (i.e., ore, mines, smelter, municipal sewage treatment plants, etc.) should have been evaluated separately. The EPA's evaluation is based on the exposure to the population today from all sources and assuming no corrective action will be taken. The EPA believes this is the most appropriate approach to qualify the risks to the public at the site since this is the true exposure to the public. The commenters disagreed with the statistical methods employed by the risk assessment, although these are the standard methods used in EPA risk assessments.

11. Comment: The commenters point out as a flaw that the ground water/surface water operable unit feasibility study (OUFS) was developed with the assumption that a water system would be implemented, but that the risk assessment included ingestion of contaminated ground water.

Response: The EPA sees no flaw in this approach. The alternatives evaluated in the ground water/surface water OUFS did not include remedial action to address the ingestion of ground water. The alternative water supply OUFS has completed an assessment of that problem. That exposure route was included in the public health assessment to show that it is an exposure pathway that must be addressed. In addition, some residents of the subsite may continue to use private shallow drinking water wells even after the alternative water system is established.

12. Comment: The commenters suggest that the Alternative Water Supply (AWS) Record of Decision (ROD) should be reopened because the estimated contaminant intakes calculated for the

ground water/surface water (GW/SW) OUFS are different from the AWS.

Response: The intake numbers expressed in the AWS OUFS and GW/SW OUFS are different. As EPA evaluated the data following the completion of the AWS OUFS, it realized there would be some minor revisions. The EPA was aware of the changes prior to signing the December 21, 1987, ROD and did not believe it made any significant difference in the decision. As shown by the public health assessment in the GW/SW OUFS, the concentrations of metals in the ground water do pose a significant public health risk. The Agency has no reason to reopen the AWS ROD.

13. Comment: The commenters state that it is inappropriate to use maximum contaminant concentrations as plausible maximum exposures.

Response: These procedures and techniques have been approved and are commonly used by EPA. As stated in the GW/SW OUFS report, the exposure assessment used the maximum values as a screening tool and based the exposures on the mean concentrations when maximum concentrations exceeded health-based standards. For example, exposures based on both maximum and mean concentrations were calculated for ground water ingestion because Direct Intake/Reference Dose (DI/RfD) ratio exceeded unity for six out of eleven metals for the 10-kg child scenario using maximum concentrations. Since these measured data are from private wells in the shallow aquifer, it is appropriate to classify them as "plausible maximum exposures."

> For soils and mine wastes, the samples were collected in the field by compositing several subsamples within the defined sampling location. Therefore, the maximum concentration a metal from the composite sample can be considered a valid "plausible maximum exposure."
>
> Further, EPA guidelines call for exposures to be based on arithmetic averages and maximum values (page 3-5-4 Superfund Exposure Assessment Manual).

14. Comment: The comments questioned the statistical treatment of the ground water data in the public health assessment (PHA). The commenters state that the PHA report does not indicate whether all the wells tap the same aquifer. They state this since the maximum concentrations of several metals exceed the average values by more than a factor of four, thus the commenters say it indicates that values come from underlying statistical distributions with long right tails. They state that it is misleading and inappropriate to summarize such variables with the arithmetic mean and maximum values.

Response: The 1988 OUFS text clearly indicates that the 123 wells sampled during the RI are private residential wells drawing water from the shallow aquifer. OUFS Appendices provide available data on well depth, but in many cases well depth and/or screen interval depth were based on owners' recollections and could not be documented due to observed well construction or lack of permission from the well owner to access the well and measure the depth. The physical characteristics of the shallow aquifer are described in detail in the OUFS.

Again, EPA standard protocols call for exposures based on mean and maximum concentrations. There is no basis for believing that contaminant concentrations are distributed lognormally at Galena.

15. Comment: The commenters state that the Public Health Assessment report supplies no justification for use of the lower MCL for hexavalent chromium. They believe the chromium at the site is trivalent chromium which is less toxic.

Response: The analytical data are reported as total chromium and the MCL is for total chromium.

16. Comment: The commenters state that while it is a standard assumption in public health risk assessments to assume a 70-kg adult ingests two liters and a 10-kg child ingests one liter of water a day, the report does not state the assumption used to evaluate the ingestion of water by a 35-kg child.

Response: In this report, quantitative risk assessments for ingestion of water were calculated for the 10-kg child and the 70-kg adult. The 35-kg child was used for swimming exposures only. The risk associated with the daily consumption of water by the 35-kg child was assumed to be somewhere intermediate of the 10-kg child and the 70-kg adult, and was not specifically quantified.

17. Comment: The commenters state that the use of the maximum values in the Public Health Assessment, without any information about the underlying statistical distributions or even the arithmetic average, is inappropriate and likely misleading. They state that often concentration measurements in natural waters follow a lognormal distribution for which the use

of a maximum value as the summary statistic is highly misleading. The effects that are of primary interest in this risk assessment are chronic, i.e., resulting from long-term exposure. The appropriate statistic to use, in the commenters' opinion, is one that represents the level of exposure that would be expected on a long-term basis.

Response: As stated previously in this responsiveness summary, maximum concentrations are useful as a screening tool. That is how they were used. These risks from both surface water pathways indicated no DI/RfD exceedances for any metal based on maximum concentrations. Therefore, risks based on mean concentrations were not calculated.

18. Comment: The commenters state that the Public Health Assessment report has not established that children swim in any of the water bodies and that it assumes implicitly that the 35-kg child swims every day of the year. They stated that these assumptions are not realistic. They say that the overly conservative assumption in this report overstates the estimated exposure by a factor of five or more above the conservative assumptions normally used to gauge these possible exposures. They state that EPA's Superfund Exposure Assessment Manual (US EPA 1986) states that: "The local recreation department may have detailed data quantifying the duration and frequency of water use for swimming. When such locale-specific data are not available, the following national averaged figures, based on data from the

Bureau of Outdoor Recreation (cite) can be applied:

- Frequency of exposure = 7 days/year
- Duration of exposure = 2.6 hours/day"

Response: The Galena Subsite Remedial Investigation Report (EPA, 1986) documents the water bodies that are popular swimming areas, mainly the "Blue Hole," large mine subsidence near the high school, and Shoal Creek at Schermerhorn Park. The remedial investigation report further states, "all surface waters are or could be used for swimming and wading." The EPA agrees with the commenters' proposed duration and frequency adjustments. However, the overly conservative scenario used in the OUFS indicates no DI/RfD exceedances, so more realistic scenarios were not developed. Adjustments to the duration and frequency for swimming would not affect the final conclusion of the risk assessment. The commenters also have other comments on the methodology used in evaluating the risk due to surface water contact. Since swimming and ingestion of water during swimming were not shown to be a risk, the comments on the conservative approach employed in the health assessment do not change the conclusions of the assessment.

19. Comment: The commenters state that neither the remedial investigation nor the OUFS has made any attempt to measure "representative" concentrations of metals in soils near Galena. The commenters believe it is inappropriate to define worse case situations and that it may overstate otherwise

"representative" or "average" analyses by as much as several orders of magnitude.

Response: The EPA is not only concerned with the average exposure, but must also address the greatest exposure. Soil samples collected during the Phase I RI were from the area downwind of the former smelter along Short Creek as documented by earlier studies. The sampling effort was designed to determine metals concentrations at several locations along the path of prevailing winds, with increasing distance from the smelter. Each location was sampled using a five-point composite technique, at two depths. These samples are representative of soil conditions downwind of the former smelter. Quantitative risks based on these samples apply only to this area, and the OUFS does not imply that these risks should apply to other areas such as residential Galena. Several occupied farmhouses are located in this area downwind of the smelter. Residents in this area are exposed to the stated risks.

Mine waste sampling during 1987 was designed to obtain samples representing the metals concentrations in mine waste piles, excluding chat; and again there was no intent, actual or implied, to state that risks based on these data were applicable to anything else except these mine waste areas. However, mine waste piles occur in or near the yards of many houses in Galena. Mine wastes also have been used throughout the area for fill material, roads and residential driveways. Therefore, the exposure scenario presented is a "plausible maximum exposure."

Furthermore, residents use the mine waste areas for recreation activities such as riding dirt bikes.

20. Comment: The commenters state that it is unlikely and inappropriate to model a 10-kg child (say, ages 1 through 3 years) as eating one gram of soil each and every day, especially dirt from the most contaminated waste piles and soils downwind of the former smelter. They went on to say parents and caretakers of children in this age range rarely let them play in industrial waste sites. Second, rain, snow, ice and frozen soils would limit the ingestion of soils on many days of the year, even if children happened to play in the most contaminated areas. Third, recent review articles suggest that one gram per day for the ingestion of soils by children is a gross exaggeration. More specifically, LaGoy (1987), in a major and authoritative review, estimates that a 10-kg child ingests an average of 50 mg of soil per day and a maximum of 250 mg of soil per day from all sources, not just from heavily contaminated sites. Similarly, Paustenbach (1987) states, "When all this published information on soil ingestion is considered, the data indicate that a consensus estimate for soil ingestion by children (age 1.5 to 3.5 years or ages 2 to 4) is about 100 mg/day. This figure was used by the EPA in its risk assessment and in the EPA Superfund Health Assessment Manual." Thus, the value of one gram/day (1,000 mg/day) assumed in this report overstates other authoritative and conservative estimates by a factor of 10 or 20 on mass alone.

Response: The scenario used in the risk assessment is realistic because, 1) several of the mining and associated waste areas are in very close proximity to residential areas, 2) there are no restrictions on accessing the waste areas and 3) residents have been known to use mine waste as sources of fill or gravel. The Superfund Exposure Assessment Manual states that the frequency of occurrence should be determined on a case-by-case basis. There were no data available to adjust the frequency based on weather conditions. The weather adjustment interpretation has been left to the reader of the document.

The Superfund Public Health Evaluation Manual which was used at the time the risk assessment was made, states that soil ingestion rates for children age two to six range from 0.1 to 5 grams per day. Further, the Superfund Exposure Assessment Manual which indicates the ingestion rate may vary from 0.1 to 10 grams per day. Therefore, the ingestion rate is within this range and was considered appropriate at the time. Recent guidance by EPA has established soil ingestion rates to be used in future program risk assessments. The ingestion rate for children who are one year through six years of age is 0.2 gms/day and for adults is 0.1 gms/day.

21. Comment: The commenters have similar comments about the ingestion of soils by adults. They believe it is unlikely and inappropriate to assume an adult would eat 0.1 gram of soil a day.

Response: The Superfund Exposure Assessment Manual and recent EPA interim guidance indicates a value of 0.1 gram per day should be used as an overall soil ingestion value for adults. Since there are houses within and immediately adjacent to the contaminated areas, the adults in question will normally be exposed to these contaminants on a daily basis.

22. Comment: The commenters disagreed with EPA's use of maximum metal concentrations in the assessment.

Response: The EPA's standard procedures require for exposure assessments to be based on maximum and mean concentrations as was done in the OUFS.

23. Comment: The commenters state that it has not been established that people catch and eat fish from the local waters.

Response: The Galena Subsite Remedial Investigation and other scientific literature on the Spring River document the fish populations and fishing activities in the area. The local fishery in Empire Lake and the Spring River above and below the lake would provide the quantity of fish for this scenario (Branson, Triplett and Hartmann, 1970). The conservative scenario in the OUFS indicated that this exposure route represented a nominal risk compared to ingestion of ground water and mine wastes and, therefore, was not refined further.

24. Comment: The commenters believe that the risk assessment overestimated the amount of fish a child would eat.

Response: The EPA agrees with the commenters. However, exposure due to ingestion of fish represents a negligible contribution to the total daily intake presented in Table 3-13 of the OUFS report. For children, using two significant digits for the total daily intake, the fish exposure does not contribute at all. Therefore, reducing the fish intake by another 20 percent would have no effect on the final conclusion of metallic contaminant total intake for children.

25. Comment: The commenters state that swimming and eating contaminated fish are not primary pathways for exposure because the other pathways are "larger" and because the analyses of the other pathways suffer from exaggerated assumptions.

Response: The OUFS report states exactly this point. Swimming and eating local fish are nominal exposure pathways compared to drinking ground water from private residential wells and incidental ingestion of mine wastes. There is no basis for the statement that ground water and mine waste ingestion scenarios are exaggerated.

26. Comment: The commenters state it is not clear that the Congress or the EPA intends that the MCLs and MCLGs developed under the federal Safe Drinking Water Act are to be used as "ARARs" for ground water in mining districts, precisely because the concentrations of some or many metallic ions may exceed the MCLs or MCLGs at present and may have done so for eons.

Response: It is EPA's policy that MCLs are ARARs for ground water at Superfund sites that is currently used as a drinking water source or could possibly be used as a drinking water source. Such policy is in accordance with cleanup standards found in Section 121(d) of CERCLA, 42 U.S.C. §9621(d).

27. Comment: The commenters question the source of the cancer potency factors used in the assessment.

Response: The Integrated Risk Information System (IRIS), the most authoritative source for cancer potency factors, was used in the assessment when values were available. Arsenic was the only carcinogen evaluated. The most recent cancer potency established by EPA's Risk Assessment Forum was used.

28. Comment: The commenters believe it is inappropriate to assess all the private drinking water wells on the maximum concentration for each compound. They state that concentrations of metals dissolved in ground water commonly follow a lognormal statistical distribution.

Response: The comparison between water quality of private wells and MCLs was based on maximum concentrations of metals observed in well waters. Maximum concentrations were used because this was a screening process, and because many wells were sampled only once. The table in the OUFS Report (Table 2-5) does report the number of wells exceeding each individual criterion and the number of wells that exceed more than one criterion simultaneously. There is no basis for the assumption that the data are distributed lognormally.

29. Comment: The commenters state that no attempt was made by EPA to distinguish between natural background conditions and man-made conditions of various sources.

Responses: The EPA did not define background conditions nor distinguish the risks based on the natural conditions and mining conditions. These sources are considered in the assessment, but are not distinguished because the public is exposed to both these sources. The commenters are concerned that EPA is remedying natural background conditions. This is not the case. The EPA is remedying contamination caused by human activities which remain a threat in its present condition to the public health and welfare.

30. Comment: The commenters question the plausibility of the exposure scenarios in the OUFS. As an example, they question whether the scenario of ingestion of soils by children is plausible.

Response: Mine waste areas are contiguous with residential neighborhoods in several different areas of Galena. Furthermore, mine waste materials have been transported into residential areas and used for numerous purposes, such as private driveways, so it is a common surface material throughout the city. Fugitive dust, movement of people and pets, and weather conditions transport that material into the houses in several Galena neighborhoods. Therefore, Galena residents and the residents in the area downwind of the former smelter, including young children, are directly exposed to these mine waste materials and contaminated soils every day. The scenario used in the OUFS is conservative, but not exaggerated.

31. Comment: The commenters discuss discharges from a facility offsite of the Cherokee County site. They also state that there are other sources of contaminants. They believe such releases should be qualified.

Response: The Galena subsite Remedial Investigation and OUFS reports both acknowledge that there are numerous sources of mining-related and nonmining-related contaminants to the surface waters in the Spring River watershed. The sampling programs included upstream control stations to document the water quality coming into the site or subsite, and downstream monitoring stations to document the water quality leaving the area. These other sources were considered qualitatively and quantitatively on a limited basis.

Because of the regional nature of the surface water quality program, it would be very costly to attempt to quantify each source of contamination and technically impossible to separately assess the environmental impact of each. There is sufficient data in the EPA reports for the reader to make a comparative assessment of the contributions from the potential sources of metals and nutrients. The OUFS and supporting documents clearly show that a considerable increase in metals loading occurs in Short Creek within the subsite, which is not related to the offsite fertilizer plant.

Permitted discharges are not addressed in this operable unit remedial action. The permitted release from the offsite fertilizer plant contains different contaminants from the contaminants that are the subject of this remedial action. The offsite fertilizer plant is located on a former mining site and, therefore, the contaminants that migrate from this site are similar to those at the Galena subsite. Evaluations in the OUFS considered the offsite-upstream source of contamination, but the selected remedy does not include remediation of that area. The Agency plans to conduct investigations at the fertilizer plant in the future. The RI and OUFS for the Galena subsite indicate that most of the subsite contamination is from sources within the subsite.

32. Comment: The commenters are concerned that the environmental risk assessment does not take into account natural background conditions.

Response: It is not possible to define natural background conditions. The risk assessment evaluates the current situation where hazardous substances have been released or where a release is threatened. The selected remedial action will remediate the areas impacted by mining activities to mitigate the exposure risks to the public health and welfare and the environment.

33. Comment: The commenters do not believe the reduced diversity of macroinvertebrates in Spring River are the result of elevated concentration of metals.

Response: The assessment of macroinvertebrate populations in the Spring River was based on existing scientific literature (KDHE 1980 and 1984; Branson 1966) since there were no site-specific studies of benthic biota conducted. Data from the macroinvertebrate studies were also compared to water quality data in the literature and data collected during the remedial investigation.

The KDHE (1980) water quality and biological survey of the Spring River and its tributarires noted low diversity and absence of several pollution-sensitive benthic groups in the lower reaches of the Spring River, and KDHE (1980) made the following statements.

- The biota in the lower reaches of the Spring River which receives mine drainage from several polluted tributaries continues to be stressed.
- Heavy metals in solution constitute a very serious form of pollution because they are very stable compounds not readily removed by oxidation, precipitation or other natural process. (This is especially true of zinc.)
- The general depletion at the downstream stations is attributed to continued exposure to lead-zinc mine drainage.
- It is postulated that zinc toxicity was probably indirectly responsible for the restricted taxa due to limited variety of food available.

- The drastic reduction in taxa, especially the mayflies, is attributed to chronic exposure to heavy metals.
- A similar biological depletion of the lead-zinc pollution sensitive MCOL group was noted in the benthic samples from Center Creek during 1964-65 pollution survey by Missouri. (Biological Data - 1973. James, Elk and Spring Basin Water Quality Report. Missouri Clean Water Commission, Jefferson City, Missouri. 1974.).pm

Scientific investigators will agree that there are several water quality parameters (such as ammonia, nutrients, organics) and physical factors (such as flow and substrate type) operating on the benthic macroinvertebrate populations in the Spring River, in addition to metals concentrations. Most would also agree that increasing nutrients and organic pollution along the Spring River probably cause some reduction of benthic diversity. However, the nine-year plus biomonitoring data base on the Spring River indicates a consistent reduction in benthic macroinvertebrates in the Kansas portion of the river and a consistent and corresponding increase in metals concentrations. Metal concentrations almost certainly play a role in reduced benthic diversity, especially since some metals are almost always above concentrations known to have a chronic effect on aquatic biota.

34. Comment: The commenters state that the sources of contaminants are not defined; therefore, the importance of the different sources of biological stress to the waterways cannot be

determined.

Response: The water quality data at numerous locations along Short Creek and at tributaries near their confluence with Short Creek, were presented in the remedial investigation and OUFS. This included stations both above and below the fertilizer plant in Missouri. The EPA reports present sufficient data to make a comparative assessment of the contributions from the potential sources of metals and nutrients. The Galena subsite OUFS and supporting documents clearly show that there is a considerable increase in metals loading in Short Creek within the subsite that is not related to the fertilizer plant in Missouri. (Refer to Table 3-30 of the OUFS).

A "Use Attainability" type analysis would be required to quantitatively assess the separate impacts; and at this time, there are no scientific methods that will allow a complete quantification of synergistic and antagonistic affects. The data adequately illustrate which tributaries to Short Creek are the major sources of metals contaminants and to document which segments of the creek experience the greatest changes in metals concentrations.

35. Comment: The commenters made several comments on the milling operation as presented in the 1988 OUFS and 1988 Proposed Plan. The volumes of the surface mine wastes, the treatability of the material and the costs were questioned.

Response: As the result of these comments, the EPA collected additional samples of the surface mine waste rock and treatability studies have been conducted. Based on these studies, the estimated costs for the act of treating the wastes were refined. In addition, an OUFS Supplement and 1989 Proposed Plan have been prepared which present revised remedial alternatives.

36. Comment: The commenters state that EPA's characterization of the waste piles conducted prior to the release of the 1988 Proposed Plan concentrated exclusively on the piles of broken rock and ignored the chat which constitutes 58 percent of the surface wastes. They state that their preliminary sampling indicates that the chat has much lower lead content.

Response: The EPA's waste characterization conducted prior to the release of the 1988 Proposed Plan concentrated on the material that it thought could be fed into a milling circuit with any possibility of reducing the metal content. The chat at that time was suspected to be low in lead. Therefore chat was not considered in the characterization study; conventional milling operations were not considered applicable. Because of these and other comments received, the EPA conducted analytical tests on the chat and found that it is not consistently low in lead. Some of the chat piles will need to be processed as is recognized in the OUFS Supplement and the selected remedy.

37. Comment: The commenters state that the waste rock sampling plan prepared and implemented prior to release of the 1988 Proposed Plan was in error because only surface samples were collected except for two locations. They do not believe the

overall waste materials present have been realistically or properly defined.

Response: The purpose of the sampling conducted prior to 1988 was to characterize the waste piles that could be processed. This goal was achieved. Analysis of split samples conducted by the commenter showed that the waste rock can be processed to remove a large percentage of the metal content.

Additional samples were collected during the week of June 6, 1988, for the bench-scale laboratory treatability tests. A backhoe was used to dig into several waste piles to collect deeper samples of the mine wastes for the treatability tests. In addition, many samples collected prior to and as preparation for the pilot leach test were from areas deep within chat and waste rock piles.

38. Comment: The commenters state that EPA divided the samples collected prior to 1988 by cone and quartering, which they do not believe is a reliable method for coarse material of a heterogeneous nature. They state that all the handling of the samples, including cone and quartering, transporting and laboratory size reduction offer the potential for gravity segregation of the heavy minerals.

Response: The EPA disagrees, coarse materials have a less likelihood of segregating and during the process of size reduction blending would occur. Also, these samples are an estimate of a very large mass of heterogeneous material. Any small deviation from the exact value would still fall into an acceptable estimate range for the waste piles.

39. Comment: The EPA estimated that 283,000 cubic yards of waste were present within eight areas delineated for sampling in the OUFS. Field work carried out by the commenters resulted in an estimate of 1,279,000 cubic yards of waste rock, chat and other mine wastes.

Response: The EPA has recognized this volume change in the OUFS Supplement and will consider it in implementing the selected remedy. Prior to 1988, the EPA only sampled and evaluated waste piles that would have a possibility of having their metal content reduced by conventional milling operations. Waste piles with low metal values, such as chat, were not taken into the waste pile volume estimate. The commenters estimated that 488,696 cubic yards of the 1,279,000 cubic yards are of waste rock, excluding chat. That is about 2/3 more material than EPA estimated, but not 450 percent more as the commenters estimated all waste material. Since the 1988 OUFS was completed, additional analytical work has shown that some of the chat will need to be processed; therefore, a revised volume estimate will be considered in the selected remedy.

40. Comment: The commenters suggest that EPA erred in calculating tonnage prior to 1988 from the waste volume estimates. The EPA has stated that 327,000 tons are present, indicating that a value of 1.15 tons per cubic yard was used. The commenters state that a standard earthmoving reference such as the "Caterpillar Handbook" indicated a value of at least 1.35

tons per cubic yard would be appropriate.

Response: A value of 1.35 tons per cubic yard is a good value for "in place" rock. The value was reduced downwards to 1.15 to take into account the broken nature of the material in the piles.

41. Comment: The commenters state that the EP toxicity type tests are a non-flow related, mass leach test that does not simulate natural conditions, because it assumes a steady state and does not take into account intensity and duration of rain fall events, drainage dynamics and the highly permeable nature of the surface wastes.

Response: The EP toxicity test, along with the other tests such as the water and acid shake tests, provide only an estimate of leach conditions. The EP toxicity test provide a worst case in a landfill scenario, whereas the water and acid shake tests provide a best and worst case scenario where acid mine drainage is involved.

42. Comment: The EPA's 1988 proposed plan is a modification of the Alternative 3 from the 1988 OUFS described in the 1988 proposed plan. The commenters state that the effectiveness of the proposed plan had not been modeled or evaluated.

Response: The EPA evaluated the effectiveness of the 1988 proposed plan prior to considering it as the preferred remedy in 1988. The 1988 proposed plan was estimated to reduce metal loadings by approximately 40 percent. It was estimated to reduce the loadings the same as the 1988 OUFS, Alternative 5. As part of the development of the selected remedy, Alternative 2, which is an updated version of the 1988 preferred remedy, was modelled by computer (as the other alternatives were in the OUFS) and was estimated to reduce metal loadings by 28 to 32 percent.

43. Comment: The commenters indicate that the concentrate from the milling process is not marketable or if there are intermediate by-products of the process which cannot be marketed, disposal as hazardous wastes could be required, causing a significant additional expense.

Response: In 1988 the EPA considered the concentrate generated from the milling/flotation process to be marketable. Additional tests conducted following the completion of the 1988 OUFS, as presented in the OUFS Supplement, indicate that the concentrate would be marketable.

44. Comment: The commenters state that EPA's 1988 proposed remedial action will have little effect on the metal levels available to enter the ground water and surface water. They state that this is because only between 40 and 70 percent of the lead is likely to be recovered by the proposed milling process, with similar low recoveries of other metals.

Response: The 1988 milling process proposed in the 1988 remedy projected the reduction of cadmium, lead and zinc levels by over 80 percent. Subsequent bench-scale tests were performed to identify the appropriate milling processes. Through these studies, EPA has determined that metals levels in the surface mine wastes would be substantially reduced. The EPA, therefore, disagrees with this comment.

45. Comment: The commenters estimate the cost to build a mineral processing facility at between 6 and 9 million dollars compared to EPA's estimate of $610,000. The commenters estimate operating cost to be between $10.53 and $13.38 per ton compared to EPA's estimate of $4 per ton.

Response: The EPA's plan outlined in the 1988 OUFS considered that a small, bare bones plant, that can be assembled onsite, would be shipped to the site on skids. Only the ball mill was considered to need a permanent foundation. The EPA has reestimated the costs in the OUFS Supplement following the treatability studies and other additional testing and consideration of information submitted by the commenters. These revised cost figures are provided in the OUFS Supplement.

46. Comment: The EPA estimates the materials handling costs to be $49,000 whereas the commenters estimate the cost to be $4.4 million.

Response: The commenter is referring to haulage costs for Alternative 2 which were estimated based on local milling of the mine wastes. These costs were underestimated in the OUFS. Revised analysis included increasing the volume of mine wastes to be hauled and the use of a central milling location. Based on this reanalysis, the revised cost is approximately $800,000 (see OUFS Supplement, Appendix F, page 28). This cost, while more than the original estimate, is much less than the 4.4 million dollars advanced by the commenter.

47. Comment: The commenters state that under the natural geologic process, metallic ions are provided to the shallow ground water system and surface water until these materials are totally oxidized and the contained ions are flushed from the area. They state that under existing conditions, it would take more than 1,000 years for the residual sulfide mineralization to be flushed from the system. The comments stated that the EPA's 1988 proposed plan would extend the time required for flushing.

Response: The EPA has not estimated how long it will take for the system to be flushed naturally. The EPA's selected remedy as well as the 1988 proposed plan would be expected to speed up the natural cleanup process. The main purpose of the action will be to protect the public health and reduce the environmental threats.

48. Comment: The commenters suggest that the no-action alternative with appropriate administrative controls could provide as much protection to human health and the environment as provided by the 1988 and 1989 proposed plans and at significantly less cost.

Response: The EPA did consider administrative controls such as fencing and posting to protect the public health, but did not consider these to be effective. These type of controls are not permanent, they only offer temporary control at best. At least one of the areas was fenced off, but tresspassers have destroyed the fence. It is difficult to get people to understand the potential dangers when the hazards are based on chronic exposure as opposed to situations where the exposure is immediate and painful.

C. Comments from PRPs to the Alternative Water Supply OUFS

The PRP specifically requested their comment letters on the alternative water supply OUFS (letter to Alice C. Fuerst dated December 10, 1987) and the Site-Wide Supply Inventory Technical memorandum (letter to Alice C. Fuerst dated February 1, 1988) to be incorporated by reference into their comments on the ground water/surface water OUFS. The comments in the former letter were responded to in the alternative water supply responsiveness summary dated December 21, 1987.

1. Comment: In the Final Technical Memorandum for the Site-Wide Water Supply Inventory (November 25, 1987) EPA sampled private water supply well prior to treatment. The commenters state that while this practice is acceptable if the purpose of the investigation is to determine the quality of the shallow aquifer. They state that it is not proper if the purpose is to determine if the water is suitable for consumption.

Response: Water samples from private wells were collected prior to any in-house treatment unit because the primary objective was to characterize the water quality of the shallow aquifer. These same samples were also used to assess the potential health risks associated with using this water resource because:

a. There was a variety of in-house treatment units ranging from simple filters to reverse-osmosis type systems. Some of these units remove dissolved metals, the contaminants of concern, and some do not.

b. The effectiveness of in-house units is highly dependent on timely servicing and maintaining the unit in good condition. Therefore, the effectiveness was expected to be quite variable and EPA or state agencies have no way to ensure their effectiveness.

c. Most in-house treatment units in the area were installed by EPA as a temporary measure to reduce the metals concentrations in water being used at selected private residences while EPA continued to work towards a permanent solution.

d. Ground water sources are usually not treated prior to use, except for chlorination of public systems. Therefore, the public health assessment was based on the assumption that most shallow wells had no treatment units (a fact based on RI surveys), new wells could be drilled at any time without adding treatment units, and existing treatment units could become ineffective or be removed at some future date.

2. Comment: The commenters believe the references to non-enforceable, non-regulatory guidelines and criteria (i.e., secondary MCLs, MCLGs and Clean Water Act criteria) are inappropriate because they are not ARARs for the Alternative Water Supply OUFS.

Response: One objective of the Sitewide Water Supply Inventory was to compare the water quality of the shallow aquifer to drinking water standards, maximum contaminant level (MCL) goals, and human health criteria based on the Clean Water Act. This objective was stated in the work plan and is consistent with the National Contingency Plan (NCP). The purpose of this Technical Memorandum was to provide an overall assessment of the ground water quality and comparison to a variety of criteria, standards and advisories is one recommended approach. This overall assessment provides a data base for the subsequent feasibility study that specifically addresses the ARARs.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) states that response actions should attain or exceed ARARs. CERCLA further states that other federal and state standards, requirements, criteria or limitations considered in fashioning CERCLA remedies and, if pertinent, should be used. Therefore, the Sitewide Water Supply Technical Memorandum would be incomplete if it did not address these other criteria.

For ground water actions, it is EPA's policy that the untreated ground water must meet MCLs if it could be a drinking water source. It is not an ARAR in the Alternative Water Supply action for the shallow aquifer to meet MCLs because the shallow aquifer is not being addressed by that action (i.e., the Roubidoux aquifer is the source). MCLs are ARARs in the shallow ground water in the ground water/surface remediation. The Alternative

Water Supply OUFS referenced secondary MCLs, MCLGs and Clean Water Act criteria because they are open criteria "to be considered" in making decisions.

3. Comment: The commenters state that it is inappropriate to use detection limits that are higher than the drinking water standard when the primary objective of the investigation is to verify compliance.

Response: First, the purpose of the investigation was not to verify compliance with the standards because compliance infers a requirement. Private water wells are not regulated by Kansas nor EPA. Second, EPA has standard detection levels it uses across the nation in most cases. In special cases, at extra expense, EPA does modify the detection limits for specific sampling events. In all cases except for selenium, the standard detection limit is at or below the MCL.

4. Comment: The commenters state that the EPA's data included both quantitative and qualitative values. There was no differentation made between actual quantitative and estimated values.

Response: The EPA conducts a very extensive quality assurance evaluation of its data. If a sample is not handled completely properly or if there is some other question about the data, they are coded as estimated values. In reality, if the data are not correct, it is actually being estimated lower than the true result. The EPA is very confident that the estimated values are at least as high, but not higher than, the actual values. If there is any doubt in this, the data are coded "I" and no estimates are reported.

A small percentage of the data used to define standard/criteria exceedances were indeed qualified with "J" or "M." The "J" qualifier signifies that the value did not meet all Quality Assured (QA) criteria and must technically be considered an estimate. The "J" qualifier does not mean that the data are unusable, but only that the value has a somewhat greater margin of error than data without a qualifier. Data qualified with a "J" are usable for the purposes of characterizing ground water quality.

Data qualified with an "M" are values that are below the detection limit required by the laboratory's contract with EPA for the given sample set. These data are above the detection limit of the instrument and are considered usable data. These data (with "M" and "J" qualifiers) were used in the Sitewide Water Supply Technical Memorandum and the AWS OUFS because they were judged more representative of the actual water quality than either the detection limit or zero concentration.

Of the 22 wells that were defined as exceeding the Safe Drinking Water Act MCLs or MCLGs (Tables 7 and 12 of the Technical Memorandum), 18 exceedances were based on data without qualifiers. Four wells were defined as having cadmium exceedances based on data qualified by "J" (Well 95, Sample BMHB9001; Well 83, Sample BMHB9004; Well 91, Sample BMHB9005; Well 48, and Sample BMHB9007). Of the four wells with qualified exceedances, one (Well 95) was confirmed by two subsequent samples that did not have qualifiers on the cadmium values (Well 95, Samples CMJB9013 and FMJB9007). The remaining three wells did not have exceedances in subsequent samples.

Data qualified by "J" were also used in determining exceedances of the secondary MCL for iron and total dissolved solids. Data qualified by "M" were used to determine exceedances of the CWA Health Criteria for nickel.

5. Comment: The commenters questioned the use of first round sample as the reported value as opposed to using an average of the two sampling rounds.

Response: The use of first-round sampling data for exceedance determination in the Sitewide Water Supply Technical Memorandum (TM) was not arbitrary. Each well was originally sampled during one of the three sampling activities (BMHB9--24 wells, DMJB--59 wells, J39B9--82 wells). Resampling was performed only at wells that had exceedances based on the first-round sample set. The best use of this data set is to allow the three first-round sample sets to represent point-in-time water quality estimates. Although temporal variations may have occurred between sampling activities, using the three sample sets as a representative group places equal statistical weight on each well in representing point-in-time ground water quality.

In the AWS OUFS, where average concentrations were reported, multiple samples taken from a single well were used to calculate the average concentration for that well. The commenters have erroneously assumed only the first sample was used.

Finally, in the AWS OUFS, multiple samples from individual wells were used to calculate the number of exceedances. In the OUFS, as in the Sitewide Water Supply Technical Memorandum, only those samples taken prior to in-house treatment units were used to calculate exceedances and average concentrations.

6. Comment: Several wells that exhibited "minor" exceedances in the first sampling had no exceedances in subsequent samples. The commenters suggested that the probable explanation for this is analytical error or procedural variability.

Response: There are several sources of potential error or data variability that influence the data base used in the project reports. As suggested by the commenters, variation within laboratory analytical procedures and field sampling procedures are two sources of variation. However, temporal variation in well water quality and the use of more than one analytical laboratory also introduce some variation. This project was not designed to compare the magnitude of these or other sources of variation, and conclusions regarding which were most important would be highly subjective. The development and implementation of quality assurance and field operation plans, however, maintained adequate control of field and laboratory procedures and ensured that data from samples that did not meet QA/QC criteria were not used.

The observation that some wells had remarkably consistent water quality (cadmium results, Tables 8 and 13), while other wells had variable water quality suggests that the hydrogeologic system is complex and that some wells are prone to temporal variations while others are not.

7. Comment: The commenters state that the use of first-round sampling results was not consistently applied in determining exceedances.

Response: In one instance, the use of first-round sampling data was indeed inconsistently applied to the determination of exceedances. The second sample from Well 3N was used instead of the first. This was the only case where a first-round sample did not have any MCL or MCLG exceedance, but a subsequent sample did. The well was resampled because the MCLG for lead was closely approached in the first-round sample. The resampling results showed total lead above the MCLG. The decision was made to use the second-round sampling data in this case because there was a responsibility to flag the well as one having elevated metals.

8. Comment: The commenters indicated that the Sitewide Water Supply Technical Memorandum states on page 3 that five wells exceeded the primary MCL for cadmium or chromium as a result of the 1985 sampling, but Table 12 indicates only four wells exceeded the standards.

Response: The statement on page 3 of the Technical Memorandum is from the Phase I RI Report. An assumption made in the Phase I RI report was that a water quality result that equaled a standard/criteria was defined as exceeding the standard/criteria. The assumption made in the Technical Memorandum, however, was that a result equal to a standard did not exceed the standard. As a result of this difference, the 10 ug/l of cadmium in sample BMHB9005 was defined as exceeding the primary MCL in the Phase I RI, and not exceeding it in the Technical Memorandum.

9. Comment: The commenters stated that two cadmium MCL exceedances were based on first-round data qualified by "J," with subsequent sampling results that show cadmium below detection. One of these wells (Well 48, original sample BMHB9007, Table 13) had three subsequent samples all showing cadmium below detection. The comments believe this well should be removed from the list of exceedances.

Response: If the MCL exceedance for Well 48 is not considered a problem because three subsequent sampling results were below the detection limit or the MCL, then any exceedance based on only one sample would be open to question. The EPA believes there is enough variability in the aquifer to be concerned about all exceedances. In the AWS OUFS, the data from all samples taken from each well were used to calculate the number of exceedances (excluding those samples that represent posttreatment samples from houses with individual treatment units).

10. Comment: The commenters believe that the administrative record for the Technical Memorandum and the AWS OUFS should be amended to state that there were no chromium exceedances, because, in their opinion, EPA used an overly conservative assumption.

Response: As stated by the commenters, chromium can be present in water in several form; however, the primary MCL and MCLG are for total chromium, not just the hexavalent chromium. The Sitewide Water Supply Technical Memorandum and the alternative water supply OUFS compared total chromium values to two criteria, the primary MCL of 50 ug/l and a proposed MCL goal of 120 ug/l that is based on total chromium. These comparisons were clearly stated in the reports.

The EPA considered the fact that there were no exceedances of the proposed MCLG and only one exceedance of the primary MCL (with the conservative assumption) during their selection of the proposed remedy for the alternative water supply.

11. Comment: The commenters stated that only eight (not 10) of the 72 wells sampled in the Galena subsite in 1985 and 1986 had "real" exceedances of the primary MCLs. Seven of these were "minor exceedances" with no likely health significance. The remaining well (Well 108, sample DMJB9036 with 170 ug/l cadmium) appears to be removed geographically and hydraulically from mining.

Response: As stated previously, the EPA does not agree with the commenters opinion of removing any of the wells with exceedance. The commenters' contention that seven of these exceedances have no likely health significance is without justification because several other factors other than just the MCL should be considered before assessing potential health risks. For example, the primary MCL considers the economic aspects of treatment as well as human health risks and the proposed MCL goals for both cadmium and lead are lower than the currently existing MCLs. Several other factors should be considered before drawing the conclusion that a small exceedance of an MCL does not represent a health significance. Well No. 108 (original sample DMJB9036) is located directly downgradient of mining based on the piezometric contours presented on Figure 4-3 in the Phase I RI and based on the locations of underground mines and shafts.

12. Comment: The commenters have drawn the assumption that the first priority areas were designated as "first" because they would have a higher incidence of contamination due to mining activity.

Response: The EPA, in designating first and second priority areas for the Sitewide Water Supply Inventory, did not have any preconceived ideas concerning extent or severity of contamination. The first priority areas were designated as first because EPA intended to sample all the wells (100 percent) in these areas. In the second priority areas, EPA planned to sample about one-fourth of the wells. The criteria used to differentiate first and second priority areas included proximity to known mining areas, geographic location within the site, and expected density of potable use shallow wells. The first priority areas were within known mining areas, but were also areas where EPA felt confident it could sample all the wells without expending an inordinate amount of effort. The two areas designated as second priority areas were expected to have relatively large numbers of private shallow wells, so EPA planned to sample only about 25 percent of the wells and not commit to sampling all the wells unless results of the 25 percent sampling indicated further sampling was warranted. One of the second priority areas was immediately adjacent to, and potentially downgradient of, the Galena subsite where ground water contamination had already been documented, so EPA was concerned about this area. The other second priority area was Lowell, the only other area within the site where there was heavy use of the shallow ground water resource.

The EPA did not necessarily expect to see a higher incidence of contamination in the first priority areas. The degree of contamination in the second priority areas, as compared to the first priority areas, indicates that factors other than just proximity to known mining areas play a role in the degree of contamination in the waters of shallow wells. One of these factors could be natural mineralization, but several factors in addition to natural mineral occurrence must be considered, such as local geology, local fracture patterns, possible presence of solution channels, pumping frequency and duration and others.

13. Comment: The commenters stated that the wells corresponding to J39B9065 and J39B9066 are outside the site boundary and should not be included in the tabulation of exceedances, and wells corresponding to J39B9062 and J39B9040 should not be included because they are not used as potable water supplies.

Response: Wells J39B9065 and J39B9066 were located outside the site boundary because they were intended to represent background water quality. Neither of these wells exhibited exceedances of MCLs or MCLGs and neither were counted as wells in the second priority areas. The Sitewide Water Supply Technical Memorandum (on page 12) states that 51 wells were inventoried in the second priority areas, but only 49 were actually sampled. As shown in Table 5 of the Technical Memorandum, the two wells inventoried but not sampled were in the West Galena area.

One well in the Baxter Springs area (J39B9062) and one well in Lowell (J39B9040) were not used as a potable water source during the sitewide inventory. The well in Lowell was considered representative of the area ground water and was used in the assessment of exceedances. The shallow well in Baxter Springs did not exceed primary MCLs or MCLGs, although is a valid well to use to evaluate the ground water quality.

14. Comment: The commenters stated that only 4 of 49 wells sampled within the Lowell and West Galena Survey Areas exceeded

primary MCLs, and all exceedances were relatively minor and of no likely health significance.

Response: The commenters correctly state that 4 of 49 wells in the second priority areas were identified as having exceeded the primary MCLs. The commenters' contention that the four exceedances are "minor" is open to interpretation and their conclusion regarding health implications is without scientific justification. The primary MCLs were promulgated under the authority in the Safe Drinking Water Act of 1972 and were based on evidence of known health effects.

The commenters contend that the selenium exceedance for the well corresponding to sample J39B9022 (Well 23N) should be excluded from the list of exceedances because it had only a minor exceedance and because a subsequent sample indicated a selenium concentration below the MCL. The issue of what should constitute a "real exceedance" of drinking water standards has been raised several times in the commenters' letter. In performing the remedial investigation of the ground water at the Galena subsite, the EPA's position has been as follows:

a. Any sample taken as a part of the RI and passing quality control tests is representative of the ground water quality at the well at the time that the sample was taken.

b. It is assumed that ground water quality is subject to temporal variability, sampling variability and analytical variability. The latter two are controlled by the QA/QC program.

c. Any well with at least one sample having an exceedance of at least one drinking water standard is considered to be a well that potentially exceeds the standards during other times of the year.

15. Comment: The commenters believe that few, if any, of the shallow wells being used for domestic supplies have exceedances of any standards. The commenters contend that only 9 percent of the wells have real documented exceedances.

Response: As previously discussed, all of the exceedances reported are real exceedances and need to be treated as such.

16. Comment: The commenters believe that neither the Sitewide Water Supply Technical Memorandum nor the AWS OUFS provides adequate consideration of the hydraulic position of the shallow wells sampled with respect to known mining disturbance.

Response: Definition of the hydraulic relationship between an individual contaminated well and the "known mining" or "flint area" involves a dynamic ground water system that makes it very difficult to impossible. First, mining areas are not all contiguous nor are they all in the "flint area." The water table is relatively level, virtually much less than 100 feet across the entire site. The ground water flows through fracture and joints, resulting in a very wide range in transmissivity from well to well. The private wells are completed in the same depth interval as the mining areas. Essentially, any individual well can be "downgradient" of a particular mining area if it pumps for a sufficiently long time. The individual wells are commonly clustered in neighborhoods, which increases the potential hydraulic connection and certainly the downgradient character of each individual well. The hydraulic connection between specific wells and mined areas could be verified, but at considerable expense and at a considerable expenditure of time, and this would still not contribute to or alter the remedial actions needed to protect human health and the environment.

17. Comment: The commenters contend that the sampling design was biased and, therefore, average concentrations of metallic ions are not a valid measure of potential contamination.

Response: Ground water sampling was not biased towards sampling the expected worst wells, or toward any other routine that would invalidate the use of average concentrations. Some areas were sampled to obtain data from about 25 percent of the shallow wells, selecting wells that were distributed fairly uniformly across the entire sampling area. Other areas were sampled so that all wells were sampled. Neither of these approaches would inherently bias an average concentration calculated from the ground water data.

Some wells that exceeded MCLs were selected by EPA for repeated analyses. In these cases, the average metals concentrations for each of these wells were first calculated, and then these averages were used to represent each well's water quality when the overall average (for wells sampled only once and for wells sampled several times) was calculated. This precluded the potential for the wells that were sampled repeatedly to bias the average when combined with wells that were sampled only once.

18. Comment: The average metals concentrations for the AWS OUFS were computed using detection limit values for samples where concentrations were less than detection limits. The commenters believe this practice significantly distorted the calculated averages.

Response: The commenters referenced the average values calculated for selenium to show that the method for calculating average metals concentrations was inappropriate. Selenium was an exception to the rule, and the method for calculating average metals concentrations in the AWS OUFS did, as the commenters state, significantly distort the average calculated for selenium. The primary problem was that the routine detection limit for selenium at the EPA Region VII laboratory was 50 ug/l, five times the MCL for selenium was not true for the other metals of concern, so the method used to calculate average concentrations in the AWS OUFS did not significantly distort the results for the other metals. Furthermore, EPA has not regarded selenium as a contaminant directly related to past mining activities in the site.

The EPA's consultant determined that the average concentration for selenium reported in the AWS OUFS (Table 3-1) was invalid shortly after the OUFS was submitted to EPA and advised EPA of this prior to signature of the AWS ROD. The average metals concentrations in the revised Table 3-1 are very similar to average values calculated by the PRPs and submitted as Table 1 in their comments on the Site-wide Water Supply Technical Memorandum dated February 1, 1988. A copy of the revised Table 3-1 is shown below:

Table 3-1
CONCENTRATIONS OF TOTAL METALS
OBSERVED IN PRIVATE WELLS

Metals	Average Observed Value (ug/l)[a]	Maximum Observed Value (ug/l)[a]
Arsenic	28.9	31[b]
Barium	83.5	390
Beryllium	1.8	4[b]
Cadmium	5.6	180
Chromium (total)	6.8	120
Copper	14.5	140
Cyanide	10	10
Iron	1,115	26,000
Lead	25.5	230
Manganese	92	3,400
Mercury	0.138	0.44
Nickel	23	270
Selenium	3.8	24
Silver	6.9	11
Zinc	841	15,000

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[a] ug/l = micrograms per liter.

[b] In these instances there were values greater than those listed; however, they were the results of higher detection limits and were listed as less than the detection limit.

19. Comment: The commenter inventoried the volume of mine waste rock material and the volume of available disposal areas. He found in the Galena are there is enough space in open pits and mine shafts to dispose of all the mine waste rock.

Response: The EPA had not made such an elaborate investigation of the volume of disposal space, but had also reached the same conclusions.